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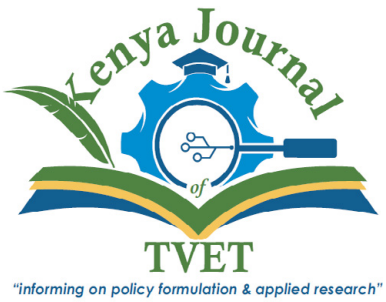

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KJ-TVET

The Kenya Journal of Technical and Vocational Education and Training (KJ-TVET), ISSN 2227–5088 is a peer reviewed Journal published by TVET Authority. Technical and Vocational Education and Training Authority is a state corporation established by TVET Act CAP 210A to regulate and coordinate training in Kenya. The Authority was established to address emerging trends and reforms in the TVET sector and provide an overall regulatory framework for all TVET providers and promote access, equity, quality and relevance. The mandate of the Authority includes among others, Advising and making recommendations to the Cabinet Secretary on all matters related to training; Promoting access and relevance of training programmes within the framework of overall national socio-economic development plans and policies; Establishing training system which meets the needs of formal and informal sectors; Collecting, examining and publishing information relating to training; Assuring quality and relevance in programmes of training; and Liaising with the National and County Governments, public and private sector on matters relating to training. In order to effectively achieve these mandates, the Authority requires reliable information for making informed decisions and recommendations. The Authority is committed to promoting TVET research and dissemination of findings through regular knowledge sharing of research findings and annual publication of KJ-TVET.

PUBLISHER

Technical and Vocational Education and Training Authority (TVETA)

MESSAGE FROM THE CHIEF EDITOR

Research plays a crucial role in guiding policy, strengthening institutional practices, and improving training programs. There is need to bridge research-to-innovation gaps, commercialize research findings and innovation, and ensure that decision-making and policy formulation are informed by research data. The KJ-TVET plays a critical role in generating sector-specific knowledge, undertaking systematic data collection and analysis, and disseminating research findings to inform policy formulation, regulatory frameworks, and evidence-based decision-making in the subsector. The Journal also promotes research in TVET subsector and provides knowledge sharing forum for dissemination of research findings. The findings and recommendations presented in this Journal are envisaged to provide solutions to various challenges or validate existing knowledge for continual improvement.

The KJ-TVET Vol. 9 is premised on the theme **Strengthening TVET Systems for Skills, Employability and Inclusive Development**, while the subthemes are; Competency Based Education and Training Implementation – Strategies, Challenges and Best Practices, Policy and Practice in Recognition of Prior Learning Implementation for Upskilling and Formalizing Skills, Sustainable TVET for Green and Blue Economies, Artificial Intelligence and Digital Technology in TVET, Role of dual training in promoting collaboration between institutions and industry for comprehensive work-based learning, Trainer Capacities and Professional Development - Strengthening TVET trainer competencies in CBET delivery and digital pedagogy. The advert on the call for submission of abstracts and papers initially attracted 61 abstracts. After rigorous double-blind review of abstracts and papers, 10 manuscripts were recommended for publication. The Editorial Board hopes that the information from this Journal will provide a reliable basis for further research, decision making, problem solving and policy formulation in TVET.

I wish to invite all researchers in TVET to read the Journal and submit their studies to be considered for publication in the subsequent volumes of the Journal. I also take this opportunity on behalf of the Editorial Board and Secretariat to convey my gratitude to all authors whose papers were recommended for publication in this volume of the Journal. I also express my appreciation to all reviewers and secretariat for meticulously going through the papers and providing appropriate recommendations on areas of improvement.

Prof. Kisilu Kitainge

Chief Editor, Kenya Journal of TVET

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ARTIFICIAL INTELLIGENCE AND DIGITAL TECHNOLOGY IN TVET

Integrating AI-Powered Adaptive Learning Systems in Competency-Based TVET Curricula: A Case Study of Nigerian Universities

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Abstract

This study examined integration of artificial intelligence (AI)–driven adaptive learning systems in competency-based Technical and Vocational Education and Training (TVET) programmes in Nigerian universities. Three research questions guided the study, focusing on the level of awareness and utilization of adaptive AI tools, instructional benefits perceived by users, and challenges limiting effective adoption. A descriptive survey approach formed the basis of the study. The target group included 598 individuals, comprising 186 lecturers and 412 students drawn from three federal universities with approved TVET programmes. Through proportionate sampling, 210 respondents were chosen for participation. Data were gathered using a structured questionnaire that had been validated at a reliability index of 0.89. Data Analysis involved the use of frequencies, percentages, mean scores, and standard deviations. Findings indicated that awareness of AI-enabled tools was moderate to high, ranging from 58.6% to 64.5%. However, utilization levels were lower, with only 54.2%-59.1% of respondents reporting regular engagement with adaptive learning systems. Analysis of instructional benefits revealed strong agreement, with mean scores ranging from 3.22 to 3.53, indicating that respondents believed AI systems improve personalized instruction, enhance learner engagement, support mastery of vocational competencies, and strengthen digital readiness for workplace tasks. Major challenges included inadequate digital infrastructure ($\bar{X}$ = 3.63), unstable electricity and internet connectivity ($\bar{X}$ = 3.61), insufficient funding ($\bar{X}$ = 3.59), and low AI literacy among lecturers ($\bar{X}$ = 3.45). Respondents also identified the absence of institutional guidelines ($\bar{X}$ = 3.33) as a significant barrier. The study concluded that while AI-driven adaptive systems have considerable potential to transform TVET, their effectiveness depends on

improved infrastructure, sustainable funding, and enhanced staff capacity. It recommended targeted investment in digital facilities, capacity building for lecturers, and increased access to digital learning devices to promote effective innovation in TVET delivery.

Keywords: Adaptive learning, artificial intelligence, Competency-based education.

Introduction

Technical and Vocational Education and Training (TVET) play a crucial role in strengthening national development because by equipping individuals with applied competencies required for industrial and economic advancement (UNESCO, 2018). In Nigeria, the importance of TVET is emphasised through ongoing efforts to reform instructional delivery, strengthen teacher capacity, and promote innovation across university-based vocational programmes (Okoli, Ejiofor, Ali & Nwakile, 2020). Global changes in technology have increased the need for new pedagogical models that ensure learners develop industry-ready skills aligned with contemporary workplace expectations (OECD, 2021). As universities continue to adopt digital technologies, Artificial Intelligence (AI) has emerged as a significant driver of innovation in teaching and learning (Zawacki-Richter *et al*., 2019).

Adaptive learning platforms that incorporate AI function by examining how students engage with learning tasks, tracking their progress, and adjusting instructional activities to suit each learner's specific strengths and difficulties (Holmes, Bialik & Fadel, 2019). Such systems have been shown to support mastery-based learning, improve learner engagement, and enhance personalized instruction in diverse educational settings (Chen, Chen & Lin, 2020). Their relevance to vocational and technical programmes is further underscored by the demand for digital competence, problem-solving skills, and flexibility in modern work environments (World Economic Forum, 2023). Scholars in Nigeria have also highlighted the need for integrating innovative technologies into vocational education to improve the quality of training and align programmes with labour market expectations (Ejiofor & Nwakile, 2016; Ifijeh & Yusuf, 2020).

Despite these potentials, the integration of AI-supported learning tools in Nigerian university-based TVET programmes remains limited due to infrastructural gaps, inconsistent policy direction, and insufficient capacity among lecturers to manage emerging technologies (Audu, Bako & Abdurrahman, 2020). Evidence shows that many TVET institutions struggle with inadequate digital facilities, irregular power supply, and limited access to modern instructional technologies (Nwakile, Eze & Okanya, 2017). Furthermore, lecturers often require additional

training to engage effectively with AI systems, especially in areas of data literacy, algorithmic interpretation, and digital pedagogy (Ogunlade & Adedoyin, 2022). Without addressing these gaps, the full instructional value of adaptive technologies may not be realized in vocational education.

The introduction of AI-enabled learning tools also raises questions about institutional readiness, learner acceptance, and the suitability of available policies to support technology-enhanced instruction (Ifijeh & Yusuf, 2020). Although several initiatives have attempted to promote digital transformation in Nigerian higher education, uptake within vocational programmes has been uneven and slow-paced (Adedeji & Ajibade, 2022). Moreover, the absence of structured guidelines for AI adoption in TVET limits the development of coordinated strategies that could enhance the quality of teaching and learning (UNESCO-UNEVOC, 2022). Consequently, there is a growing need for empirical studies that examine how adaptive AI systems are currently utilised, their perceived benefits, and the challenges that hinder their effective integration in vocational and technical education in Nigerian universities.

This study, therefore, seeks to provide empirical evidence on the extent of awareness and utilisation of AI-driven adaptive learning systems within university-based TVET programmes. It also investigates the instructional value attached to such systems and the constraints limiting their adoption among lecturers and students. The study contributes to ongoing discussions on digital transformation in Nigerian higher education by offering insights that can guide policy development, lecturer capacity building, and strategic investment in emerging technologies.

Objectives of the Study

The main objective of this study was to determine the integration of artificial intelligence (AI)–driven adaptive learning systems in competency-based Technical and Vocational Education and Training (TVET) programmes in Nigerian universities. The specific objectives of the study were:

i. To ascertain the current level of awareness and utilisation of AI-driven adaptive learning systems in university-based technical and vocational programmes.

ii. To determine the perceived instructional and learning benefits of integrating adaptive AI systems into vocational and technical education.

iii. To ascertain the challenges hindering the effective integration and utilisation of adaptive AI learning systems in these programmes.

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

H_{01}: There is no significant difference between lecturers and students in their level of awareness and utilisation of AI-driven adaptive learning systems in university-based Technical and Vocational Education and Training (TVET) programmes.

H_{02}: There is no significant difference between lecturers and students in their perceived instructional and learning benefits of integrating adaptive AI systems into university-based.

H_{03}: There is no significant difference between lecturers and students in their perceived challenges hindering the effective integration and utilisation of adaptive AI learning systems in university-based Technical and Vocational Education and Training (TVET) programmes.

Theoretical Framework

This study is grounded in the Technology Acceptance Model (TAM), introduced by Fred D. Davis in 1989, which explains how users develop intentions to adopt and use new technologies in organisational and educational environments. The model emphasises two central determinants of technology acceptance: perceived usefulness and perceived ease of use. Perceived usefulness relates to users' beliefs that a technology can improve the effectiveness or efficiency of task performance, while perceived ease of use refers to the extent to which the technology is considered simple and effortless to operate.

Applied to university-based Technical and Vocational Education and Training (TVET), TAM provides a useful framework for understanding how lecturers and students may respond to AI-driven adaptive learning systems. Adaptive AI technologies are introduced with the expectation that they can improve instructional delivery, personalise learning experiences, and support competency-based training. Lecturers' and students' awareness of such technologies may shape initial perceptions of their relevance, while perceptions regarding instructional value, usability, and required skills are likely to influence decisions about actual use. In this regard, perceived instructional and learning benefits align conceptually with perceived usefulness, whereas issues such as digital infrastructure, AI literacy, and institutional support relate to perceived ease of use.

By adopting TAM as the guiding theoretical framework, this study provides a structured basis for examining awareness, utilisation, perceived benefits, and challenges associated with AI-driven adaptive learning systems in TVET

programmes. The model is particularly suitable for this study because it allows for an integrated examination of individual perceptions and contextual conditions that may influence technology acceptance in higher education environments, especially within developing-country contexts where institutional and infrastructural factors play a critical role.

Methodology

This study employed a descriptive survey research design to address three formulated research questions. The research was conducted across three federal universities in South-West Nigeria that offer accredited TVET programs. The descriptive survey design was considered appropriate for this study because it enabled the systematic collection of data on existing conditions, perceptions, and practices relating to the integration of AI-powered adaptive learning systems among lecturers and students in university-based TVET programmes. Unlike experimental designs, which require controlled manipulation of variables, this study sought to examine naturally occurring levels of awareness, utilisation, perceived benefits, and challenges across institutions without introducing interventions. A mixed-methods approach was also not adopted because the study objectives were primarily descriptive and explanatory rather than exploratory, and the use of structured quantitative data was sufficient for identifying prevailing trends across a relatively large and heterogeneous population.

The descriptive survey design provided a practical and methodologically sound approach for generating generalisable evidence on AI integration practices within the Nigerian TVET context. The total population consisted of 598 participants, including 412 TVET students and 186 lecturers. The sample size for this study was determined not only to ensure representativeness but also to provide adequate statistical power for both descriptive and inferential analyses. From a total population of 598 lecturers and students, a sample of 210 respondents (170 students and 40 lecturers) was selected using proportionate sampling to maintain subgroup balance across institutions and respondent categories. This sample size exceeds the minimum threshold commonly recommended for survey research involving large and heterogeneous populations, where samples above 200 are considered sufficient to yield stable estimates of central tendency and variability (Nworgu, 2015).

The selected sample size was considered appropriate for the application of chi-square and independent-samples t-test analyses, which require adequate cell frequencies and reasonable group sizes to produce reliable results. The lecturer and student subsamples were sufficiently large to satisfy the assumptions of these statistical tests, thereby reducing the risk of Type I and Type II errors. In addition, the high response rate achieved enhanced the reliability of the

dataset and strengthened the robustness of the findings. Overall, the sample size was deemed methodologically adequate to support valid group comparisons and generalisable conclusions within the context of university-based TVET programmes.

Data for the study were obtained through a structured questionnaire titled *AI Integration in TVET Questionnaire (AI-TVETQ)*. Content validity of the instrument was established through expert review by three specialists in Educational Technology and Vocational Education from the University of Nigeria, Nsukka. To ascertain reliability, the instrument was pilot-tested in a similar institution, yielding a Cronbach's Alpha coefficient of 0.89, which indicates a high level of internal consistency. The questionnaire was administered using both physical and electronic formats, and 203 valid responses were retrieved, representing a response rate of 96.7%.

Data analysis involved use of frequency counts and percentages, mean scores and standard deviations.. Interpretation of mean scores was based on a cut-off point of 2.50, such that items with mean values of 2.50 and above were regarded as *Agree*, whereas those with mean values below 2.50 were regarded as *Disagree*. In addition to descriptive analysis, the stated null hypotheses were examined using inferential statistics. The chi-square (χ^2) test was applied to determine whether significant differences existed between lecturers and students in their levels of awareness and utilisation of AI-driven adaptive learning systems. Differences in perceived instructional benefits and challenges of AI integration between lecturers and students were analysed using the independent-samples t-test. All hypotheses were tested at the 0.05 level of significance, with null hypotheses rejected when the calculated *p*-value was less than or equal to 0.05, and retained when the *p*-value was greater than 0.05.

Results and Discussions

Table 1 shows a summary on the Analysis of Awareness and Utilisation of AI-Driven Adaptive Learning Systems by the Respondents.

Table 1

Frequency, Percentage, and Chi-Square Analysis of Awareness and Utilisation of AI-Driven Adaptive Learning Systems by Respondent Group (N = 203)

S/N	Item	A (%)	NA (%)	U (%)	NU (%)	Lecturers (%)	Students (%)	χ^2	Rem	Dec
1	Awareness of adaptive AI learning platforms	64.5	35.5	—	—	75.0	61.3	4.21	A	S
2	Knowledge of AI-supported assessment tools	58.6	41.4	—	—	70.0	55.8	3.96	MA	S
3	Awareness of personalised learning dashboards	62.1	37.9	—	—	72.5	59.5	4.08	A	S
4	Use of AI tools during coursework	—	—	56.2	43.8	52.5	57.1	1.84	PU	NS
5	Access to institution-provided AI learning software	—	—	49.8	50.2	47.5	50.3	0.62	NWU	NS
6	Exposure to AI-based feedback systems	—	—	47.8	52.2	45.0	48.5	0.71	NWU	NS
7	Use of adaptive quizzes and learning paths	—	—	54.2	45.8	50.0	55.5	1.92	PU	NS
8	Participation in AI-supported virtual learning activities	—	—	59.1	40.9	55.0	60.1	2.04	U	NS

Key: A = Aware; NA = Not Aware; MA = Moderately Aware; PU = Partially Utilised; NWU = Not Widely Utilised; U = Utilised; NU = Not Utilised; S = Significant ($p < 0.05$); NS = Not Significant ($p \geq 0.05$); Dec = Decision; Rem = Remark

Note: Percentages for Lecturers (n = 40) and Students (n = 163) represent within-group proportions, indicating the percentage of each subgroup that reported awareness or utilisation of the specified AI tools.

Findings in Table 1 showed that respondents exhibited a moderate to high level of awareness of AI-driven adaptive learning systems, as indicated by the Remark column. Awareness levels ranged from 58.6% to 64.5%, suggesting that AI-related instructional tools are increasingly recognised within university-based TVET programmes in Nigeria. This pattern reflects broader global trends in

higher education, where awareness of AI in teaching and learning has expanded faster than its actual instructional use (Zawacki-Richter et al., 2019; Holmes, Bialik & Fadel, 2019).

The chi-square results indicated statistically significant differences between lecturers and students on all awareness-related items. Lecturers consistently reported higher awareness levels than students, with between 70.0% and 75.0% of lecturers indicating awareness compared to 55.8%–61.3% of students. This finding suggests that lecturers are more exposed to AI concepts through curriculum planning roles, institutional briefings, and professional development activities. Such a pattern aligns with evidence that educators often encounter pedagogical innovations earlier than learners within formal education systems (UNESCO, 2018).

However, utilisation-related items were largely not statistically significant (NS), despite moderate utilisation levels reflected in the Remark column. Utilisation percentages ranged from 47.8% to 59.1%, with most items classified as Partially Utilised (PU) or Not Widely Utilised (NWU). This indicated that although AI-driven systems are recognised, their integration into routine instructional practice remained limited. Similar awareness–utilisation gaps have been widely reported in Nigerian higher education, particularly where infrastructural constraints, funding limitations, and inconsistent institutional support persist (Audu, Bako & Abdurrahman, 2020).

Interestingly, students recorded slightly higher utilisation percentages than lecturers across most AI-supported learning activities, including adaptive quizzes, coursework-related AI tools, and virtual learning environments, although these differences were not statistically significant. This suggests that students may be more inclined to engage with available digital tools when such technologies are embedded in learning tasks. This pattern is consistent with Ejiofor and Nwakile (2016) who found that learners often act as primary adopters of instructional technologies once access barriers are reduced.

From a policy alignment perspective, the findings revealed a gap between policy aspirations and institutional practice. Nigeria's TVET and higher education policies emphasise digital innovation, skills relevance, and technology-enhanced learning as drivers of employability and national development (Federal Ministry of Education, 2014). However, the moderate utilisation levels observed suggest that institutional capacity has not yet matched these policy objectives. At the continental level, the African Union Continental Strategy for TVET similarly highlight digital and adaptive learning technologies as central to strengthening competency-based education and workforce readiness across Africa (African Union Commission, 2024). The present findings indicate that while awareness of

AI-driven learning aligns with these frameworks, structural and implementation barriers continue to constrain effective utilisation within Nigerian university-based TVET programmes.

This study extended existing Nigerian TVET literature by demonstrating that AI integration challenges are implementation-driven rather than awareness-driven, particularly within competency-based university contexts. By combining descriptive Remarks with inferential Decisions, the study provides clearer analytical insight into lecturer–student differences and contributes context-specific evidence to the growing discourse on AI-in-Education in sub-Saharan Africa.

Perceived Instructional and Learning Benefits of Integrating Adaptive AI Systems into Vocational and Technical Education

Table 2

Mean Ratings, Standard Deviations and t-test of Perceived Instructional Benefits (N = 203)

S/N	Perceived Benefits	$\bar{X}g$	SD	$\bar{X}_1$	$\bar{X}_2$	t	Rem	Dec
1	Enhances personalised and self-paced learning	3.42	0.73	3.48	3.36	2.31	A	S
2	Facilitates mastery of practical vocational competencies	3.38	0.77	3.44	3.32	2.18	A	S
3	Increases learner engagement and motivation	3.53	0.68	3.56	3.50	1.42	A	NS
4	Provides immediate and automated feedback	3.31	0.82	3.36	3.26	2.06	A	S
5	Helps identify learners' performance gaps	3.36	0.75	3.42	3.30	2.12	A	S
6	Supports differentiated instructional delivery	3.29	0.79	3.34	3.24	2.04	A	S
7	Improves student retention and understanding of concepts	3.25	0.84	3.28	3.22	1.58	A	NS
8	Encourages independent learning and critical thinking	3.34	0.81	3.38	3.30	2.01	A	S
9	Strengthens digital readiness for workplace demands	3.47	0.71	3.50	3.44	1.69	A	NS
10	Enhances student–teacher interaction through digital channels	3.22	0.86	3.28	3.16	2.27	A	S
	Overall mean	**3.35**		**3.40**	**3.30**			

Key: $\bar{X}_1$ = Lecturers mean; $\bar{X}_2$ = Students mean; $\bar{X}g$ = Grand mean; SD = Standard Deviation; Rem = Remark; Dec = Decision

The study revealed that respondents generally perceived AI-enabled adaptive learning systems as instructionally beneficial, as reflected by an overall grand mean of 3.35, which is above the criterion mean of 2.50. This indicates that both lecturers and students agreed that adaptive AI systems contribute positively to teaching and learning within university-based TVET programmes. This positive perception aligns with global reports indicating that artificial intelligence is increasingly recognised as a tool for transforming instructional delivery, learner support, and assessment practices in higher education (Zawacki-Richter et al., 2019).

High grand mean values were recorded for instructional benefits related to learner engagement and motivation (3.53), digital readiness for workplace demands (3.47), and personalised and self-paced learning (3.42). These findings suggest that adaptive AI systems are perceived as particularly relevant for competency-based TVET, where learner-centred instruction and alignment with labour market expectations are central. Similar conclusions have been reported in studies indicating that AI-driven learning platforms enhance learner motivation, flexibility, and the acquisition of transferable digital skills required in contemporary work environments (Holmes, Bialik & Fadel, 2019; Chen, Chen & Lin, 2020).

Although overall perceptions were positive, comparative analysis showed that lecturers reported slightly higher mean ratings than students on several instructional benefit items, particularly those related to personalised instruction, mastery of vocational competencies, automated feedback, and differentiated instructional delivery. This pattern suggests that lecturers may be more sensitive to the pedagogical and diagnostic value of adaptive AI systems, especially in relation to curriculum implementation, learner monitoring, and assessment processes. This finding is consistent with Okoli et al. (2020) who found that lecturers often perceive greater instructional usefulness in digital technologies due to their direct engagement with instructional planning and evaluation responsibilities.

In contrast, no statistically significant differences were observed between lecturers and students on items relating to learner engagement, student retention and understanding, and digital readiness for the workplace, despite relatively high grand mean scores. This convergence in perception suggests that these benefits are directly experienced by students through interaction with adaptive learning systems rather than mediated primarily through instructional design. Similar patterns have been reported in previous studies where both instructors and learners expressed comparable views on engagement- and employability-related

outcomes of digital and AI-supported learning environments (Chen, Chen & Lin, 2020).

The generally favourable perception of instructional benefits must, however, be interpreted within the broader institutional context. Despite strong agreement on the value of adaptive AI systems, actual utilisation remains moderate in many Nigerian universities. This reflects the position that educational institutions in developing contexts often experience slow and uneven adoption of emerging instructional technologies due to infrastructural limitations, funding constraints, and institutional readiness challenges (Ogunlade & Adedoyin, 2022). This observation also supports UNESCO's (2018) assertion that many TVET institutions in low- and middle-income countries struggle to keep pace with rapid technological change, despite recognising its instructional potential.

Hence, the findings indicate that while AI-driven adaptive learning systems are widely perceived as beneficial for enhancing teaching and learning in university-based TVET programmes, translating these perceived benefits into sustained instructional practice requires addressing systemic and infrastructural barriers. By demonstrating strong perceived instructional value alongside modest differences in lecturer and student perceptions, the study contributes context-specific evidence to the growing literature on AI integration in competency-based TVET within the Nigerian higher education system.

Challenges hindering the effective integration and Utilization of Adaptive AI Learning Systems in University-based TVET Programmes

Table 3 shows the Mean Ratings, Standard Deviations and t-test of Perceived Challenges to AI Integration.

Table 3

Mean Ratings, Standard Deviations and t-test of Perceived Challenges to AI Integration (N = 203)

S/N	Challenges	$\bar{X}g$	SD	$\bar{X}_1$	$\bar{X}_2$	t	Rem	Dec
1	Inadequate digital and technological infrastructure	3.63	0.66	3.70	3.56	2.44	A	S
2	Low AI literacy among lecturers	3.45	0.77	3.58	3.32	2.36	A	S
3	Insufficient institutional funding for technological adoption	3.59	0.69	3.65	3.53	2.21	A	S
4	Absence of clear implementation guidelines on AI utilization	3.33	0.84	3.41	3.25	2.02	A	S
5	Limited access to laptops and smart devices among students	3.29	0.88	3.24	3.34	1.61	A	NS
6	Poor internet connectivity and unstable electricity supply	3.61	0.62	3.68	3.54	2.38	A	S
7	Resistance to technological change among academic staff	3.18	0.91	3.26	3.10	1.74	A	NS
8	Concerns about data privacy and misuse of digital information	3.27	0.86	3.35	3.19	1.69	A	NS

Key: $\bar{X}_1$ = Lecturers mean; $\bar{X}_2$ = Students mean; $\bar{X}g$ = Grand mean; SD = Standard Deviation; Rem = Remark; Dec = Decision

The study revealed that respondents agreed that multiple systemic and institutional factors constrain the effective integration of adaptive AI learning systems in university-based TVET programmes. This is evidenced by high grand mean scores, particularly for inadequate digital infrastructure ($\bar{X}g$ = 3.63), poor internet connectivity and unstable electricity supply ($\bar{X}g$ = 3.61), and insufficient institutional funding ($\bar{X}g$ = 3.59). These findings indicate that infrastructural and resource-related challenges remain the most critical barriers to AI adoption in Nigerian universities. This pattern aligns with global and regional evidence suggesting that technological innovation in higher education

is heavily dependent on foundational infrastructure and sustained investment (UNESCO, 2018).

The significant t-test results further showed that lecturers perceived these infrastructural and funding-related challenges more strongly than students, particularly in relation to digital infrastructure, electricity and internet stability, funding, and the absence of clear implementation guidelines. This difference may be attributed to lecturers' direct responsibility for instructional delivery, curriculum implementation, and assessment, which makes them more sensitive to structural deficiencies that hinder effective teaching. This finding supports Ogunlade and Adedoyin (2022) who indicated that lecturers are often more acutely aware of institutional constraints affecting technology integration due to their professional roles within the instructional system.

Low AI literacy among lecturers also emerged as a significant challenge, with lecturers reporting higher mean scores than students. This suggests recognition among academic staff of capacity gaps in understanding and applying AI-driven instructional tools. The finding is consistent with research showing that insufficient digital and AI-related competencies among educators remain a major obstacle to pedagogical innovation in developing contexts (Ogunlade & Adedoyin, 2022). It further reinforces the argument that successful AI integration in TVET requires not only infrastructure but also sustained professional development and capacity building.

In contrast, challenges relating to students' access to digital devices, resistance to technological change, and data privacy concerns did not show statistically significant differences between lecturers and students, despite being rated as important constraints. This convergence suggests that both groups experience these challenges in similar ways, reflecting shared exposure to broader socio-economic and institutional realities within Nigerian higher education. Comparable findings have been reported in studies indicating that digital access limitations and privacy concerns affect both instructors and learners within technology-mediated learning environments (Chen, Chen & Lin, 2020).

Findings showed that although stakeholders recognise the instructional value of adaptive AI systems, infrastructural, funding, and capacity constraints continue to limit effective implementation in university-based TVET programmes. This aligns with UNESCO's (2018) assertion that TVET institutions in low- and middle-income countries often struggle to translate technological awareness into practice due to structural barriers. By highlighting these challenges and lecturer–student perceptual differences, the study contributes context-specific evidence to ongoing debates on AI integration in Nigerian TVET.

Conclusions and Recommendations

Conclusions

The research examined the incorporation of AI-powered adaptive learning systems within university-level Technical and Vocational Education and Training (TVET) programs in Nigeria. The findings revealed that although awareness of AI-enabled instructional tools is relatively high among lecturers and students, utilisation remains moderate due to limited institutional access and infrastructural deficiencies. Respondents recognised the instructional value of adaptive systems, particularly their ability to personalise learning, enhance engagement, and strengthen mastery of vocational competencies. These benefits align with global trends advocating for technology-supported pedagogical innovation in vocational education.

However, the study identified major challenges such as inadequate digital infrastructure, unstable power supply, insufficient funding, low AI literacy among lecturers, and a lack of clear institutional guidelines to support implementation. These constraints continue to hinder the full adoption of adaptive AI technologies across university-based TVET programmes. Addressing these limitations is essential for aligning vocational education with contemporary labour market demands and for positioning Nigerian institutions to benefit from global advancements in AI-enabled learning.

Recommendations

1. Investment in Digital Infrastructure: Government and university management should prioritise the provision of reliable internet access, modern computing facilities, and stable electricity to support AI-enabled learning environments.
2. Capacity Building for Lecturers: Regular training workshops and professional development programmes should be organised to enhance lecturers' competence in using AI-driven adaptive learning systems.
3. Development of Institutional and National Guidelines: Relevant education regulatory bodies should develop clear policies that outline standards, ethical considerations, and procedures for integrating AI technologies into TVET programmes.
4. Ensuring Student Access to Digital Learning Tools: Universities should implement technology support initiatives, such as subsidized laptop programs or device loan schemes, to enhance students' access to AI-enabled learning resources.

Areas for Further Research

Additionally, comparative studies across different types of institutions, such as federal, state, and private universities, as well as colleges of education and polytechnics would help to determine how institutional characteristics influence the adoption of AI-enabled learning technologies within TVET. This would enhance the generalisability of findings across the Nigerian higher education system. It would also be important for future investigations to focus on specific AI applications, such as intelligent tutoring systems, learning analytics dashboards, or AI-supported assessment tools, to examine their differential impacts on competency acquisition and learning outcomes in vocational education. Examining discipline-specific applications within TVET fields would further strengthen practical relevance.

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Generative Artificial Intelligence-Driven Simulations for Competency-Based Vocational Training: Evidence from Kenyan TVET Institutions

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Abstract

Technical and Vocational Education and Training (TVET) institutions have been identified as the main drivers for achieving Kenya's national development goals. The transition to Competence-Based Education and Training (CBET) seeks to equip graduates with practical, workplace-ready skills rather than focusing on theoretical knowledge. However, challenges such as inadequate infrastructure, outdated equipment, and limited trainer capacity continue to impede implementation of CBET. While simulation-based learning has been widely applied in fields such as aviation, healthcare, and engineering, its use in Kenyan TVET institutions remains minimal. Generative Artificial Intelligence (GenAI) offers an opportunity to deliver adaptive, cost-effective, and dynamic simulations that could address these gaps. This study assessed the availability of infrastructure required to support simulation-based learning, evaluate trainer preparedness for using GenAI-driven tools, and examine institutional and policy support for integrating simulations into CBET delivery. A qualitative desk-based review was employed, drawing exclusively on secondary sources selected based on relevance to TVET and CBET, credibility of publication, and applicability to Kenya's policy and institutional context. The review focused on policy documents, peer-reviewed research, institutional reports, and authoritative media published between 2018 and 2025. Analysis revealed three key themes: persistent technological and infrastructural deficits, especially in rural institutions; uneven trainer capacity, with limited digital competencies and minimal exposure to simulation tools; and policy frameworks that emphasize digital transformation but lack explicit strategies for integrating AI-driven simulations. These findings suggest that GenAI-driven simulations are feasible for advancing CBET in Kenyan TVET institutions; however, their successful adoption will require targeted policy actions. Specifically, the results highlighted the need for a coordinated national strategy on digital infrastructure investment, structured continuous professional development that includes simulation technologies, and policy mechanisms to formalize partnerships supporting AI integration. Such insights can inform future TVET policy by guiding resource allocation, trainer development programs, and national standards for simulation-based learning.

Keywords: GenAI, simulation-based learning, competency-based education and training

Introduction

Background Information

In the recent past, TVET has become an important subsector in the Kenyan education sector. It is increasingly getting obvious that TVET institutions are being recognized as drivers for social and economic transformation. In Kenya, TVET institutions are touted as the institutions that would play a key role in the achievement of Vision 2030. One of Kenya's blue print initiatives by the government's Big Four Agenda, which is made up of youth employability, innovation, and industrial competitiveness (Republic of Kenya, 2019), is expected to be driven by TVET institutions. The shift to Competency-Based Education and Training (CBET) seeks to ensure that graduates demonstrate workplace-ready skills rather than theoretical knowledge (Mulder, 2017). The need to drive the growth of TVET institutions in Kenya has made it necessary for policy reforms. However, TVET institutions continue to face systemic challenges, including resource inadequacies, outdated training equipment, and weak industry linkages (Mwinzi, 2020), Consequently, graduates often leave institutions insufficiently prepared to meet evolving labour market demands.

The growth of the digital age has led to new technologies such as Artificial Intelligence (AI) and especially generative AI (GenAI). Generative Artificial Intelligence (GenAI) refers to AI systems capable of creating new content, including text, images, or simulations, based on patterns learned from existing data. Unlike general digital tools, such as Learning Management Systems (LMS), Virtual Reality (VR), or Augmented Reality (AR), which primarily deliver or visualize pre-designed content, GenAI enables dynamic, adaptive learning experiences that can generate personalized training scenarios and real-time feedback. These technologies hold transformative potential for addressing the challenges. The use of digital tools like AI in education can be used to simulate actual workplace scenarios that can provide real-time feedback (Zawacki-Richter *et al.,* 2019). Globally, simulation-based training has already been successfully applied in high-stakes fields such as aviation, medicine, and engineering (Aebli *et al.*, 2020). In sub-Saharan Africa, the application of AI in workplace simulations in vocational training Institutions is minimal

In Sub-Saharan Africa, however, the application of AI-driven simulations in vocational training is minimal. Given Kenya's policy shift toward CBET, the exploration of GenAI's feasibility in TVET contexts is both timely and necessary. In Ethiopia, the federal institute has integrated some small-scale AI simulations in their training while Senegal is currently carrying out a pilot program for AI driven learning platform. In Kenya, Homa Bay County has recently partnered

with Sama to roll out an AI curriculum in vocational training Institutes. The program, which was launched in 2024, will equip students with AI skills and integrate them into routine training.

Problem Statement

Technical and Vocational Education and Training (TVET) institutions in Kenya continue to face various obstacles in making their training relevant to the present employment market, despite supportive legislation and global interest in enhancing education using modern technologies. Although the shift to Competency-Based Education and Training (CBET) is a step in the right direction, its advancement is hampered by inadequate infrastructure, antiquated training tools, and a lack of trainers who are knowledgeable about contemporary teaching techniques. The practical, hands-on experience that students need to thrive in today's complicated and rapidly evolving businesses is frequently lacking in traditional classroom techniques. These learning tools allow students to practice real-world tasks in a safe, controlled environment. However, in Kenya's TVET system, the use of such simulations is still very limited. Use of simulators has enhanced training in industries like manufacturing, healthcare, and aviation in numerous nations. Information regarding whether Kenyan TVET institutions have the resources, qualified personnel, and supportive policies required to implement and sustain simulation-based learning is conspicuously lacking. Efforts to enhance training may be ill-planned or fail if there is insufficient proof of their readiness and willingness to use such techniques. Therefore, the purpose of this study is to assess how prepared Kenyan TVET institutions are to support practical, skills-based training under the CBET system by using simulation technologies.

Objectives of the Study

The purpose of this paper was to examine the readiness of TVETS in Kenya to adopt and implement simulation-based tools in support of CBET. The specific objectives of the study are to:

i. Assess the availability of infrastructure and technological resources necessary for implementing simulation-based learning in Kenyan TVET institutions.

ii. Evaluate the capacity and preparedness of trainers in TVET institutions to use simulation tools in delivering CBET curricula.

iii. Examine the institutional and policy support available for integrating simulation-based learning into the TVET system in Kenya.

Significance of the Study

This study is significant because it seeks to address the gap between the dynamics of the labour Market and the skills as determined by the training approaches in Kenyan TVET institutions. The research provides insight that can inform policymakers, educators, learners, and other stakeholders on the best approaches to invest in the training. Understanding the readiness of TVET institutions to take up AI simulation is an important step towards the adoption and integration of generative AI.

Literature Review

As a revolutionary pedagogical method in vocational education, the incorporation of simulation-based learning within the Competency-Based Education and Training (CBET) framework has garnered international attention. Despite a growing policy emphasis on modernizing education and aligning it with labour market needs, the viability of using generative artificial intelligence (GenAI) to drive simulation-based learning in Kenya's Technical and Vocational Education and Training (TVET) institutions is still largely unexplored.

Theoretical Foundations

Davis (1989) created the Technology Acceptance Model (TAM), which offers a helpful theoretical framework for comprehending how organizations accept new technologies. According to the hypothesis, two important aspects that affect a technology's acceptability are perceived utility and perceived ease of use. TAM provides a lens through which to analyze how trainers' opinions of the usefulness and efficacy of AI-powered learning resources impact their willingness to implement them in the context of GenAI-driven simulations in Kenyan TVET institutions. Furthermore, two essential elements of CBET implementation—institutional support and policy backing—act as enabling circumstances that either facilitate or impede adoption.

Information technology (IT) has a chance to significantly contribute to young people's skill development through the use of generative learning in CBET. By making it possible to create dynamic, adaptable learning environments, generative AI gives simulation-based learning a new dimension. The realism and scalability of vocational training are improved by GenAI's capacity to create customized training scenarios, mimic difficult tasks, and offer real-time feedback. According to Zawacki-Richter *et al*. (2019), GenAI has the ability to increase access to practical training experiences while drastically reducing the cost of simulation infrastructure. The TAM model highlights the significance of perceived utility, usability, institutional backing, and infrastructure preparedness as crucial elements impacting the uptake of innovations such as GenAI-powered simulations.

Empirical Literature

Infrastructure and Technological Resources

The infrastructure issues that TVET institutions in Kenya face have been the subject of numerous studies. These studies have demonstrated Kenya's progress in incorporating technology into education. Musyimi (2021) asserts that while there has been significant success in increasing access to electricity and internet connections, much work remains in updating training materials and programs. According to statistics, 80% of Kenya's public TVET institutions do not have access to the cutting-edge tools required for practical technical instruction. Power stability, dependable internet, and high-performance computer systems—all necessary for GenAI-driven simulation—remain scarce, especially in rural and underserved areas.

The State Department for TVET (2024) released a report that recognized digitization gaps and proposed ways of digitizing TVET infrastructure, such as incorporating augmented reality (AR) and virtual reality (VR) into training curricula. These programs, however, are mostly in their pilot phases and are centred in a small number of urban areas and national polytechnics. For instance, a collaboration between Sama technology and Homa Bay County intends to implement an AI curriculum at a few institutions, but there isn't a comprehensive national framework directing the broad use of simulation-based technology. Although VR and AR offer lifelike settings, they usually depend on scenarios that have already been created. Advancement and background. GenAI is especially pertinent for improving CBET delivery in Kenyan TVET institutions because of its capabilities.

Significant infrastructural deficiencies that directly affect the quality of vocational education were discovered in a report by the International Labour Organization (ILO, 2023) that evaluated welding and fabrication training facilities in counties including Garissa and West Pokot. These results imply that although the policy landscape is improving, infrastructure preparedness for GenAI-driven simulation is still inconsistent and frequently inadequate. Although several studies have offered descriptive information regarding the availability of infrastructure, they frequently haven't assessed the real influence of these resources on the learning outcomes of students under CBET. Additionally, a large portion of the data concentrates on metropolitan institutions, ignoring systematic disparities in rural and underprivileged areas. This demonstrates the need for additional evaluative studies that connect infrastructure preparedness to real-world simulation-based learning implementation.

Trainer Capacity and Preparedness

Another important factor influencing the viability of introducing simulation-based learning in TVET institutions is trainer readiness. The Kenyan government has made significant efforts to retrain TVET instructors under the CBET framework, although these efforts have mostly concentrated on pedagogical conformity with industry standards rather than digital literacy or the use of cutting-edge educational tools. Because it is likely to assist trainers in adjusting to the new technologies, retooling trainers inside the CBET framework is a crucial activity. In order to lead students via individualized, skill-focused pathways, trainers need to possess both pedagogical skills and up-to-date technical knowledge, according to a UNESCO report from 2021. This shift requires trainers to move beyond traditional teaching models and adopt the role of facilitators who can support diverse learning styles and provide real-world, job-ready training experiences

Simulation-based learning and generative AI are effective techniques for improving CBET delivery. The development of immersive, scenario-driven experiences that replicate real-world workplace difficulties is made possible by these technologies. For instance, trainers can utilize generative AI to create personalized simulations, produce contextual tests, and provide learners with immediate, data-driven feedback. In addition to boosting student engagement, these resources aid in the growth of critical thinking, decision-making, and problem-solving skills. Additionally, simulations offer a secure setting where students can practice high-stakes tasks without facing real-world repercussions, strengthening proficiency prior to practical application (Bresnick, 2023).

Trainers themselves must participate in structured professional development that develops digital literacy, instructional design proficiency, and ethical awareness surrounding AI use in order to successfully incorporate these technologies (World Economic Forum, 2023; Smith & Jones, 2022). A retooled trainer is one who can use AI to assess learner performance data, develop adaptive learning environments, and constantly enhance training based on real-time insights (Brown, 2021; World Economic Forum, 2023). Competency-Based Education and Training (CBET) must undergo this change in order to meet the demands of Industry 4.0, where workforce competences are being redefined by automation, data analytics, and innovation (World Economic Forum, 2023; Lee *et al.*, 2022). As such, investment in trainer retooling is not merely a modernization effort but a strategic necessity for delivering relevant, future-ready vocational education (World Economic Forum, 2023; Johnson, 2020).

By 2023, the Kenya School of TVET had retooled over 924 trainers, and an additional 580 were receiving comparable training. Although there is little proof that these programs incorporate modules on AI, VR, or simulation tools, their

goal is to improve trainers' ability to teach competency-based curricula (Kenya News Agency, 2024). Furthermore, due to a lack of institutional support for experimenting with new tools and a lack of exposure to simulation technologies, many trainers continue to rely on traditional lecture-based methods, according to research by Muchira *et al.* (2023).

Regional differences can make trainer readiness much more difficult. For example, the CBET effort has trained over 1,500 trainers in the Coast region, but similar initiatives have not reached outlying regions with the same vigour. The implementation of GenAI-driven simulation will probably encounter opposition or underutilization at the institutional level in the absence of extensive and ongoing professional development programs centred on digital competences and simulation technologies. Few studies evaluate whether retooling activities for trainers effectively increase the usage of simulation or AI tools in instructional practice, despite the fact that extant literature promotes these attempts. The attitudes, motivations, and contextual difficulties of trainers while applying CBET with sophisticated technology are also not often discussed, indicating a gap that the current study aims to fill.

Institutional and Policy Support

Technology-enhanced, competency-based learning is generally supported by Kenyan national policy. A nationwide plan for the switch to CBET in TVET institutions is provided by the Competency Based Education and Training Policy Framework (2018). Additionally, the need of continuous skill development and professional growth among trainers is emphasized in the Draft National Policy on Continuous Professional Development for TVET Trainers (2024). Additionally, the Technical and Vocational Education and Training Authority (TVETA) has created a Strategic Plan (2023–2028) that highlights infrastructure development and digital transformation as top priorities. Nevertheless, despite these encouraging advancements, comprehensive, implementable rules addressing the incorporation of simulation-based learning—particularly with AI or immersive technologies—remain lacking.

For instance, while certain universities, including Dedan Kimathi University of Technology, have started experimenting with VR and AR learning technologies, these programs are institution-specific rather than part of a coordinated national effort. Furthermore, simulation-based programs lack a formal accreditation system, raising questions about whether skills learned on these platforms would be recognized. Overall, although Kenya's policy framework is evolving in the right direction, it currently lacks the specificity, funding mechanisms, and implementation guidelines required to support widespread adoption of generative AI-driven simulations in vocational education. Although policy

documents indicate a favorable climate for CBET and technology adoption, there is little critical assessment of the efficacy of the policies or their viability for large-scale implementation. In particular, the absence of formal accreditation for simulation-based learning raises questions about standardization and quality assurance, which remain largely unexplored in the literature.

Methodology

This study employed a qualitative desk-based research design to assess the feasibility of adopting generative AI-driven simulations within the Competency-Based Education and Training (CBET) framework in Kenyan Technical and Vocational Education and Training (TVET) institutions. The study was exploratory in nature and relied exclusively on secondary data sources, including policy documents, academic publications, institutional reports, and reputable media articles.

Research Design

Given the absence of primary field data and the focus on evaluating institutional readiness from existing documentation, a qualitative descriptive methodology was chosen. This approach allows for an in-depth understanding of contextual factors influencing the adoption of technology in education. The study was organized around three core areas of analysis: infrastructure and technological readiness, trainer capacity and preparedness, and institutional and policy support for simulation-based learning.

Data Sources

The following standards were used to choose the data sources: Credibility, timeliness (they must have been published between 2018 and 2025), relevance to CBET, TVET, AI, or simulation-based learning, and contextual applicability to Kenya. The Competency Based Education and Training Policy Framework (2018), the Strategic Plan of TVETA (2023–2028), and the Draft National Policy on Continuous Professional Development for TVET Trainers (2024) were among the data sources. These were published in peer-reviewed journals, especially those that addressed curriculum development, TVET technology adoption, and trainer capacity. Media articles and institutional announcements that offer current information on pilot programs, public-private partnerships, and policy developments.

The study used a desk-based methodology employing secondary data from government publications, institutional assessments, and national policy papers rather than a primary sample of institutions or trainers. All registered Technical and Vocational Education and Training (TVET) institutions in Kenya, classified as national polytechnics, technical training institutes, and vocational training

centers, as well as the national TVET trainer workforce, made up the population of interest. Instead of survey data from a sampled subset of institutions, the percentages given in the study are synthesized national-level estimates obtained from aggregated secondary sources.

Data Collection and Analysis

A content analysis methodology was used to perform a methodical assessment of the documents. Every source was assessed for its applicability to the three goals of the study. Thematic indicators were used to extract and classify the data. The availability of ICT infrastructure and simulation tools, the breadth and depth of trainer retooling programs, measures of institutional preparation, and the state of policy directives and execution were among the thematic indicators. Findings from several data sources were combined using thematic analysis. To ascertain consistency in the application of policies and institutional support, gaps and contradictions were identified and examined.

The gap between present capabilities and the ideal circumstances needed for the successful implementation of GenAI-based simulations in vocational training was assessed using a straightforward gap analysis approach. Tables 1-3 were created using a methodical synthesis of quantitative data found in scholarly papers, institutional reports, and government policy documents. The available numerical data or percentage was retrieved for each indication such as computer access and AI tool training. The study employed triangulation to balance discrepancies and generate a single representative estimate in cases when data from several sources overlapped. The study also employed inferential reasoning based on similar indicators (such as the number of universities with ICT labs) in situations where direct data was not available, making sure to explicitly identify them as synthesis estimates. The infrastructure readiness, trainer readiness, and institutional/policy support for simulation-based learning in Kenyan TVET institutions were then summarized at the national level using these combined data.

Reliability, Validity, and Limitations

The results were triangulated using several data sources to improve dependability. Peer-reviewed academic sources and government policy documents are used to support the study's validity. However, the study's dependence on secondary data, which might not accurately represent the most recent or regional advancements in all schools, is a limitation. Furthermore, a thorough evaluation of the economic viability of simulation-based technologies is limited by the absence of financial information about their cost and sustainability.

Results and Discussions

The study relied on secondary data sources and qualitative analysis. The data were categorized under the three key areas of analysis: infrastructure readiness, trainer preparedness, and institutional and policy support. A review of institutional reports, government publications, and existing literature revealed the following:

Infrastructure and Technological Readiness

Table 1

Availability of Technological Infrastructure in Kenyan TVET institutions

Indicator	National Polytechnics (N=11)	Technical Training Institutes (N=150+)	Vocational Training Centers (N=700+)
Stable electricity	95%	72%	54%
Reliable internet	88%	58%	32%
Modern training equipment	42%	21%	14%
Access to computers	63%	37%	19%
Access to simulation tools (VR, AR, AI-based)	10%	3%	<1%

Note: The percentages were obtained from secondary sources, such as ILO (2023), State Department for TVET (2024), and TVETA (2023–2028). Triangulation between reports and inferential estimates in cases of missing data were used for aggregation. Only roughly 10% of national polytechnics and less than 3% of technical training institutions seem to have any kind of simulation-based tools, according to secondary data that is currently accessible. Instead of direct measurement from specific institutions, these estimates are based on combined findings from several reports. The remarkably low percentage of trainers trained in simulation technologies (6%) indicates a severe skills gap that could impede the effective adoption of GenAI tools, despite the fact that the majority of trainers have completed CBET retooling. The unequal allocation of resources between urban and rural institutions and the lack of emphasis on digital competences in current professional development programs could be the causes of this disparity. Low experience to AI tools may lower trainers' perceived confidence and simplicity of use, which could hinder adoption even in cases when infrastructure is present, according to the Technology Acceptance Model. This result is consistent with observations made worldwide that trainers need both technical and pedagogical support in order to successfully integrate cutting-edge digital tools into vocational education.

Institutional and Policy Support

Table 2

Institutional Policy and Support

	Status	Notes
Alignment with CBET framework	High	Ongoing rollout since 2018
Inclusion of simulation-based learning in curriculum	Low	Not explicitly provided in syllabi
Funding provision for digital tools	Low to moderate	Mostly project-based
Public–private partnerships	Moderate	e.g., Homa Bay–Sama AI initiative
Trainer CPD on digital competencies	Low	No national guideline for AI integration
Accreditation framework for simulation learning	Very low	No formal recognition system

Both qualitative and quantitative information from official publications, government policy documents, and institutional announcements served as the foundation for institutional/policy support indicators. Ratings are not based on direct survey data, but rather on the synthesis of several sources. An examination of institutional records and policy papers suggests that Kenya has a favorable policy climate for CBET, despite the fact that there is still little use of digital and AI-based training programs. The findings also demonstrate that simulation-based assessment lacks a certification system, which may restrict its adoption. Another significant limiting element was discovered to be funding constraints. There is proof that Kenya has a strong legislative framework that supports the modernization of CBET and TVET; yet, the lack of clear regulations for simulation tools indicates a significant gap in simulation accreditation requirements and inadequate national guidelines.

Conclusions and Recommendations

Conclusions

The preparedness of Kenyan TVET institutions to include simulation-based learning within the CBET framework was investigated in this study. The results showed that core capacities exist, but there were also serious shortcomings in terms of infrastructure, teacher proficiency, and policy support. However, it should be mentioned that only secondary sources were used in the analysis. As a result, rather than being direct measurements across all institutions, the provided percentages and observed trends were synthesis estimates that could not accurately reflect recent or localized developments. To confirm and expand

on these findings, more investigation using source data and thorough field surveys is required.

Recommendations

Based on the findings from this study, Generative AI–Driven Simulations for Competency-Based Vocational Training: Evidence from Kenyan TVET Institutions. The following recommendations were proposed.

1. Invest in AI-ready infrastructure (High Priority): The government can establish a national fund to support TVET institutions in acquiring modern training facilities and infrastructure.
2. Strengthen trainer capacity (High Priority): The government and other partners should implement a systematic nationwide professional development program to equip instructors with the requisite skills.
3. Develop clear policies and accreditation frameworks (Medium–High Priority): Introduce national guidelines for simulation-based learning, including standards for AI adoption, accreditation of GenAI-based programs, and monitoring mechanisms.
4. Leverage public–private partnerships strategically (Medium Priority): Expand initiatives like the Homa Bay–Sama AI program and other collaborations to scale best practices and provide sustainable support for digital learning.

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Integrating Chat Generative Pre-Trained Transformer (ChatGPT) in Pedagogy Practices of University Technology Educators in Oyo and Ogun State, Nigeria

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Abstract

Inclusion of artificial intelligence in pedagogy practices for the sole purpose of handling difficult task for effective output prompted the researchers to access the integration of Chat Generative Pre-trained Transformer - ChatGPT in pedagogy practices of university technology educators in Oyo and Ogun State, Nigeria. Three research questions guided the study. Descriptive survey research design was adopted for the study. The population for this study consisted of 40 technology educators in two university offering technology education in Ogun State and Oyo State. Total enumeration was used to select all 40 technology educators as study sample. The instrument used for data collection was 28-item structured questionnaire which was designed on a modified 4-point Likert scale titled: 'ChatGPT Questionnaire'. The instrument was face and content validated by three research experts. 0.90 reliability co-efficient (r) value was obtained through Cronbach Alpha reliability. 40 copies of the questionnaires were retrieved by the researchers which yielded 100% return rate. Mean and Standard Deviation was used to analysed the data using mean score at 2.50 and above as criterion for acceptance. Findings revealed that ChatGPT still remain unpopular in technology education classroom setting despite its flexibility in handling difficult task. Hence, study recommended that university management should organize workshop training for technology educators on the need for inclusion of ChatGPT in their pedagogy practice. Also, curriculum planners and policy makers should ensure that regulations and policies are conducive to both teachers and learners on ChatGPT integration into technology education curriculum.

Keywords: Generative ChatGPT, pedagogy practices, technology educators

Introduction

Artificial intelligence (AI) was first recognized as a field of study in the 1950s, it was defined as a systematic capacity to comprehend, learn and perform particular tasks from data. Because of these characteristics as well as the shown outputs involving social, emotional and cognitive display, it was

categorized as "analytical, human-inspired intelligence." Recent innovations and breakthroughs have made it more common for people to employ artificial intelligence (AI) in everyday tasks, such as incorporating it into tools used by a variety of businesses. This suggests that ChatGPT should be included into daily use, demonstrating the benefits of leveraging AI as a potent instrument to raise the effectiveness and status of teaching.

ChatGPT is a conversational system built on top of the large-scale GPT (Generative Pre-trained Transformer) language model. The goal of this product is to leverage natural language processing technologies to provide easy, organic discussions with human users. Customer service, educational tutoring, entertainment interactions and many other areas can benefit from the use of ChatGPT (Kocoń et al., 2023; Obi & Anaege, 2023; Opele, Alade & Ajifowoke, 2024). It is thought that by incorporating ChatGPT into technology educators' practices, they will be able to intelligently develop courses that cater to the needs and interests of their students. By analyzing students' data, ChatGPT can provide insights regarding the optimal topic sequencing, favored learning styles and any gaps in the course material (Robinson, 2018). Lecturers can use this information to design more interesting and productive learning activities, data analysis, pattern recognition, decision-making and effective teaching method.

Teaching methodologies in a general term refer to a set of practices and principles used by teachers to make the process of teaching and learning highly effective for their students (Noga, 2014). In the context of this study, teaching methodologies refer to different strategies deployed by technology educators in aiding learning facilitation and communication of instructional content to students. Technology educators adopt ways of passing instructional information to learners in the classroom and thereby impact them with skills that will make them competent as well as become professional in their chosen fields. On the other hand, evaluation technique is the assessment of learning activities done by educators to measure students' competence. Noga (2014) submitted that in evaluating a teaching learning process, educators need some aspects and techniques to measure the students' achievement such as homework, presentation, observation, project among others.

The Technology Acceptance Model (TAM) developed by Fred Davis in 1986, is the foundation of this investigation. The hypothesis sheds light on the variables affecting how new technologies are adopted and accepted in educational settings. Perceived Utility (PU) and Perceived Ease of Use (PEOU), two fundamental components of TAM, are its foundation (Hubert *et al.,* 2018). The degree to which a person thinks a specific technology will improve their job performance or make their responsibilities simpler and more effective is known as Perceived Usefulness (PU). Users are more inclined to accept and use technology if they believe it is worthwhile and advantageous for their work, which makes

perceived usefulness a crucial component in technology adoption. On the other side, perceived ease of use, or PEOU, refers to how much people think utilizing a technology will be simple and effort-free. Users are more likely to accept a technology if they believe it to be user-friendly. On the other hand, adoption can be impeded if people perceive it as difficult or complex (Hubert *et al.,* 2018). This theory will provide an insight for technology educators on integration of ChatGPT to classroom pedagogy practices.

Statement of the Problem

A brief glance at Nigeria's higher institutions reveals that, far from embracing the use of contemporary technologies, many technology educators in the system still heavily rely on a demonstrational style of instruction. Technology education pedagogy appears to be beset by a number of problems, including inefficient methods of instruction and learning, inadequate resources for students to learn from, inadequate facilities and equipment for teaching and learning in courses with a practical focus, difficulty using current technologies and inadequate methods for evaluating students' academic performance. It follows that new technologies are not included in Nigerian university classrooms due to the surrounding challenges. This suggests that educators of technology are still falling behind the rapid advancements in the field. Hence, need for the study.

Objectives of the Study

The main objective of the study was to access the integration of Chat Generative Pre-trained Transformer - ChatGPT in pedagogy practices of university technology educators in Oyo and Ogun State, Nigeria. Specifically, the study sought to:

i. assess the level of awareness of university technology educators on ChatGPT for pedagogy practices.

ii. determine the extent of utilization of ChatGPT by university technology educators for pragmatic approach.

iii. investigate the extent of utilization of ChatGPT by university technology educators for students' evaluation.

Methodology

The study adopted descriptive research design of survey type. The population for the study consisted of 40 technology educators in two universities offering technology education in Ogun and Oyo State which are, Tai Solarin University of Education, Ijagun (Lecturers – 10; Instructors – 4) and Emmanuel Alayande University of Education, Oyo. (Lecturers – 18; Instructors – 8). Total enumeration technique was used to select 40 technology educators as the study

sample because of manageable size. A structured questionnaire designed based on existing literature and titled ChatGPT Questionnaire was used to collect data. The questionnaire contains two section A and B. Section A sought for demographic data of the respondents while B focused on the research questions raised for the study. The questionnaire has 21 items with 4 point modified Likert scale of High Extent (HE-4); Moderate Extent (ME-3); Slight Extent (2) and Low Extent (LE-1). The questionnaire was face and content validated by three research experts. One from Department of Technology Education, One from Department of Computer Science and the last one from Department of Educational Foundation in Emmanuel Alayande University of Education, Oyo. A pilot test of the questionnaire was conducted with ten (10) technology educators from Lagos State University of Education, Oto/Ijanikin, who were not included in the study population. The reliability of the instrument was determined using Cronbach's alpha, yielding a coefficient of 0.90, which was considered sufficiently high for the study. Data were collected by the researcher and 100% return rate was achieved. Descriptive statistics of mean and standard deviation was used to analyzed the research questions.

Results and Discussions

Awareness Levels of University Technology Educators on ChatGPT for Pedagogy Practices

Table 1

Respondents mean score on level of awareness of university technology educators on ChatGPT for pedagogy practices.

S/N	Items	Mean	SD	Decision
1.	ChatGPT can be part of classroom learning resources	2.01	0.56	Slight Extent
2.	ChatGPT can identify relevant refences materials	3.45	0.58	Moderate Extent
3.	ChatGPT is a useful tool in lesson planning or preparation	2.16	0.57	Slight Extent
4.	ChatGPT can be employed to solve basic technical problems	1.00	0.56	Low Extent
5.	ChatGPT can aid in developing lesson contents or materials	1.76	0.54	Low Extent
6.	ChatGPT is a form of modern technology	3.45	0.55	Moderate Extent
7.	ChatGPT can be install on smartphones and computers	2.54	0.57	Moderate Extent
	Average Mean	**2.34**	**0.56**	**Slight Extent**

Source: **(Author, 2025)**

From Table 1, the mean scores on level of awareness of university technology educators on ChatGPT for pedagogy practices ranged from 1.00 to 3.45. This clearly indicated that the respondents reacted negatively to the seven items with a grand mean of 2.34. The results also showed the standard deviation ranged from 0.57 to 0.60 indicating that the respondents were not far from one another in their responses, proving that the items were valid.

Utilization of ChatGPT by University Technology Educators for Pragmatic Approach

Table 2

Respondents mean score on utilization of ChatGPT by university technology educators for pragmatic approach.

S/N	Items	Mean	SD	Decision
1.	Technology educators engage ChatGPT in interactive dialogue, posing questions, providing explanations and offering feedback.	2.21	0.87	Slight Extent
2.	ChatGPT is used to explain complex concepts in a clear and understandable manner. Likewise, to clarify doubts or elaborate on topics they find challenging.	2.00	0.85	Slight Extent
3.	Unlike human educators, ChatGPT is available around the clock, providing instant assistance to technology educators whenever they need it.	3.42	0.86	Moderate Extent
4.	Technology educators utilize ChatGPT in integrating multimedia elements such as images, videos and links to enrich the learning experience with visual aids and supplementary materials.	2.01	0.85	Slight Extent
5.	ChatGPT assist technology educators teaching languages by providing translations, grammar explanations and practice conversations in the target language.	2.43	0.86	Slight Extent
6.	Technology educators engage ChatGPT on a diverse dataset covering many domains, allowing it to provide information and answer queries on a broad array of topics.	2.11	0.87	Slight Extent
7.	Technology educators utilize ChatGPT in discussions that require critical thinking and analysis, helping them develop essential skills.	2.21	0.84	Slight Extent
8.	ChatGPT assists technology educators in creating and developing relevant instructional aids to reinforce teaching.	2.02	0.87	Slight Extent

Table 2 ***(Continued)***

Respondents mean score on utilization of ChatGPT by university technology educators for pragmatic approach.

S/N	Items	Mean	SD	Decision
9.	ChatGPT is used by technology educators to develop teaching contents with relevant examples in real life situation.	2.56	0.85	Moderate Extent
10.	Technology educators engage ChatGPT in provide detailed, step-by-step instructions for practical tasks such as operating machinery.	3.01	0.84	Moderate Extent
11.	Technology educators utilize ChatGPT to offer real-time support during practical sessions, providing immediate answers to questions or clarifications on procedures without the need for human supervision.	1.78	0.86	Low Extent
12.	Technology educators utilize ChatGPT to provide information on safety guidelines, compliance regulations and best practices in vocational fields like construction, automotive repair.	1.26	0.86	Low Extent
	Average Mean	2.25	0.85	Slight Extent

Source: **(Author, 2025)**

Data presented in Table 2, showed the mean score of the data from the respondents' view about the utilization of ChatGPT by university technology educators for pragmatic approach. Item 3 showed the highest mean score of 3.42 which stated that ChatGPT is available around the clock, providing instant assistance to technology educators whenever they need it. The average mean score of 2.25 was obtained meaning that the respondents agreed that the utilization of ChatGPT by university technology educators as pragmatic approach was to a low extent. The results also showed the standard deviation ranged from 0.84 to 0.87 indicating that the respondents were not too far from one another in their responses, proving that respondents' opinions or responses were similar.

Utilization of ChatGPT by University Technology Educators for Students' Evaluation

Table 3

Respondents mean score on utilization of ChatGPT by university technology educators for students' evaluation

S/N	Items	Mean	SD	Decision
1.	Technology educators engage ChatGPT in assessing students' performance on specific tasks or assignments by providing criteria-based evaluations.	1.01	0.61	Low Extent
2.	ChatGPT generate detailed feedback to technology educators on students' work, highlighting strengths, areas needing improvement and specific suggestions for improvement.	3.32	0.65	Moderate Extent
3.	Technology educators utilize ChatGPT to assign scores or grades to students' submissions based on predefined grading scales or criteria.	2.65	0.64	Moderate Extent
4.	Technology educators engage ChatGPT to track students' progress over time by analyzing their performance on repeated assessments or assignments.	3.11	0.61	Moderate Extent
5.	ChatGPT suggest adaptive learning paths to technology educators based on students' assessment results, recommending additional practice exercises, remedial resources or advanced challenges to further develop students' skills.	2.87	0.64	Moderate Extent
6.	Technology educators utilize ChatGPT to provide real-time assessment of students' responses to questions or tasks, offering immediate feedback and corrections to ensure understanding and accuracy.	2.00	0.63	Slight Extent
7.	ChatGPT generate performance analytics reports that summarize students' achievements, areas of proficiency, and areas for improvement. Technology educators utilize these reports to make data-driven decisions to optimize teaching strategies and interventions.	2.45	0.65	Slight Extent
8.	Technology educators utilize ChatGPT with multimedia elements such as images, videos or interactive simulations to assess students' skills that require visual or hands-on demonstration.	2.12	0.63	Slight Extent
9.	Technology educators utilize ChatGPT to provide real-time answers to student questions during practical sessions, offering clarifications and additional explanations as students engage with hands-on tasks.	2.47	0.64	Slight Extent
	Average Mean	2.44	0.63	Slight Extent

Source: **(Author, 2025)**

Data presented in Table 3, showed the mean score of the data from the respondents' view about the utilization of ChatGPT by university technology

educators for students' evaluation. Item 2 showed the highest mean score of 3.32 which stated that ChatGPT generate detailed feedback to technology educators on students' work, highlighting strengths, areas needing improvement and specific suggestions for improvement. The average mean score of 2.44 was obtained meaning that the respondents agreed that the utilization of ChatGPT by university technology educators for students' evaluation was to a low extent. The results also showed the standard deviation ranged from 0.61 to 0.65 indicating that the respondents were not too far from one another in their responses, proving that respondents' opinions or responses were similar.

Results and Discussions

Findings from the first objective revealed that technical educators' level of awareness on the utilization of ChatGPT for pedagogy practices was to a moderate extent. This means that ChatGPT is not popular among technical educators for classroom use. Although ChatGPT supports smartphones, findings revealed that only few educators have the application on their mobile phones. This finding aligns with the study of Robinson (2018) who posited that most of the educators in tertiary institutions do not include AI as part of their teaching learning process. Similarly, Sani, Adeyemi and Bakare (2022) added that modern technologies still remain unpopular in classroom settings despite its flexibility in handling difficult tasks in the pedagogy process. He further stressed that this occurs as a result of technology educators' attitude to accept the use of technology coupled with paucity of funds for its acquisition among others.

Based on research question two, results revealed that university technology educators slightly adopt ChatGPT as a pragmatic approach. This is contrary to the assertion of Obi and Anaege (2023) and Opele, Alade and Ajifowoke (2024) who stated that ChatGPT is widely used across various sector including educational settings. In addition, Serhan and Welcome (2024) posited based on the pattern ChatGPT writing, most educators find it boring to include it in their teaching learning process. Findings from research question three indicated that technology educators utilized ChatGPT for students' evaluation to a low extent. It was also found that ChatGPT does not have features which can be adopted for students' evaluation. This finding is contrary to the view of Opele *et al*., (2024) who stated that ChatGPT has the capability to generate questions for the assessment process.

Conclusions and Recommendations

Conclusion

The study concluded that university technology educators currently lack a sufficient level of awareness and understanding of ChatGPT for pedagogy practice. This highlights a notable gap in knowledge and awareness within the

educational setting, suggesting that there is significant room for improvement in terms of educating and familiarizing technology educators with ChatGPT. It is also important to note that, despite the initial lack of awareness and understanding, the integration of ChatGPT has the potential of assisting technology educators in their pedagogy process cum effective students' evaluation.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. University management should organize workshop training for technology educators on the need for inclusion of ChatGPT in their pedagogy practice.
2. Curriculum planners and policy makers should ensure that regulations and policies are conducive to both teachers and learners on ChatGPT integration into technology education curriculum.

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A Systematic Review of Digital Transformation in TVET: Leveraging AI for Scalable and Inclusive Skills Assessment in Kenya's ODeL Platforms

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Abstract

The increase in trainees' enrolment, implementation of Competency-Based Education and Training (CBET) and the increased adoption of Open, Distance and e-Learning (ODeL) have led to increased need for scalable, objective, and inclusive skills assessment within the Technical and Vocational Education and Training (TVET) subsector in Kenya. This review synthesized evidence on the application of Artificial Intelligence (AI) to TVET assessment in Kenyan ODeL systems based on the thematic analysis of 25 peer-reviewed articles (2018-2025) using the PRISMA 2020 framework, to suggest a strategic model of equitable and sustainable implementation. The results showed that AI-based evaluation methods have shown quantifiable performance gains. Computer vision systems have been shown to perform with up to 85% accuracy in comparison to the scores given by an instructor in practical tests, and predictive analytics models have been shown to be better than traditional regression tools (R2 = 0.68 vs. 0.41) at predicting patterns of learner performance. The Adaptive diagnostic systems alleviated assessment fatigue by an estimated 35 percent and natural language processing tools increased how efficient automated feedback was. Nevertheless, implementation is still limited by poor digital capacity, low levels of digital/AI literacy among educators, disjointed implementation of policies, and unaddressed ethical-equity issues of rural and underserved learners. The review offers a context-based strategic roadmap addressing these challenges, which is based on three mutually reinforcing pathways, namely: (1) creation of flexible and resilient digital infrastructure by relying on cloud-based solutions; (2) promotion of sustained pedagogical transformation and human-centered capacity building; and (3) entrenching equity as a core design principle. This strategy offers unique and evidence-based policy suggestions, which go beyond generic international frameworks by directly taking into consideration the infrastructural shortfalls, digital inequalities and socio-technical barriers confronting Kenya. Although recent studies tend to emphasize the potential and issues of AI in TVET, this paper is part of an ongoing discussion by offering a roadmap of action to overcome the particular barriers of the field, such as monetary, infrastructural, and pedagogical, so that the field develops in an equitable way in the context of low-resource settings.

Keywords: Artificial intelligence, skills assessment, assessment policy, systematic review

Introduction

Technical and Vocational Education and Training (TVET) is a key engine of socio-economic growth in Kenya to deal with intractable unemployment and skills-mismatches among young people which limits economic growth and social mobility (Kiarie, 2025). The TVET supports national development agendas directly by equipping learners with relevant competencies required in the labour market. In Kenya, the Vision 2030 identifies TVET subsector as a strong contributor to industrialization in major sectors of the economy, including manufacturing, construction, and information technology (Kiarie, 2025; Onatere-Ubrurhe & Ubrurhe, 2025).

Labour markets are rapidly digitalizing at the global level hence requiring increased flexibility and digital fluency. Kenya is implementing Competency-Based Education and Training (CBET), where actual skills are given more emphasis than theoretical learning, to effectively match training to the evolving demands of the industry (Kiarie, 2025; Barongo *et al*., 2024). However, CBET application has revealed shortcomings in current assessment systems that include human bias, lack of consistency, manual labor inefficiency, and lack of mechanisms to measure competencies valid, reliable, and in a geographically dispersed institution (Kiarie, 2025; Yan *et al.*, 2025).

The systemic weaknesses were further worsened by the COVID-19 pandemic and the necessity to develop resilient technology-enabled models of learning and assessment (Miseda & Wanami, 2022; Katam and Otieno, 2021). Thus, Open, Distance and e-Learning (ODeL) has become a strategic priority to increase accessibility and flexibility of TVET delivery (Munyi *et al*., 2023; Munene, 2023). In this respect, Artificial Intelligence (AI) including machine learning, natural language processing, computer vision, and predictive analytics can have a significant potential to revolutionize TVET assessment. The AI can perform complex assessments, provide personalized feedback, assist in adaptive learning processes, and scale up, objective assessment of competencies (Faisal e*t al*., 2025; Ghosh and Ravichandran, 2024; Azizah *et al*., 2025).

It is against this backdrop that the current review was intended to synthesize evidence on AI-supported assessment in ODeL systems in Kenya, and to present a strategic model that can be used to integrate these systems in a fair and large-scale manner. Such a clear focus made sure that the research both exposes opportunities and also touches upon the infrastructural, pedagogical, and ethical issues peculiar to the TVET sector in Kenya.

Problem Statement

The integration of AI into TVET assessment represents a complex socio-technical transformation rather than a simple technological upgrade, particularly in resource constrained economies such as Kenya. Existing literature presents three mutually reinforcing problems namely, infrastructural and technical constraints, such as poor ICT infrastructure, unreliable internet connectivity, and weak technical support (Avedi *et al*., 2024; Muiruri, 2023); human capital shortage, specifically a lack of digital and AI skills among TVET instructors (Harberts *et al*., 2025; Kiarie, 2025); and systemic and ethical challenges, such as poor policy implementation, data risk, and algorithm bias. Although the topic of digital transformation in education has been extensively researched, there is still inadequate synthesized evidence on AI-based assessment in ODeL environments and context-sensitive TVET systems in developing nations. This review attempts to fill this gap by analyzing evidence in Kenyan to inform a strategic roadmap for equitable and sustainable use of AI in TVET assessment.

Research Questions

The paper synthesized academic findings to provide comprehensive insight on the opportunities, challenges and strategic points on the use of AI in TVET skills assessment in Kenya. The study was guided by the following research questions:

i. How has digital transformation and ODeL been adopted in the TVET sector in Kenya, with respect to preparation to advanced AI-supported assessment technologies?

ii. What are the demonstrable ways of using particular AI technologies to increase the effectiveness, scalability, and objectivity of competency-based skills assessment in TVET?

iii. What are the main technical, pedagogical and ethical challenges of installing AI-based assessment systems in the Kenya TVET context, which is resource-constrained?

iv. What evidence-based policy intervention, strategic approach, and design principles can make effective, equitable, and sustainable introduction of AI in TVET assessment?

Literature Review

The TVET in Kenya operates within a complex and interconnected ecosystem which consists of National Polytechnics, Technical and Vocational Colleges and Vocational Training Centers, which together deliver training to 800,000 learners

every year (Kiarie, 2025; Abdullah *et al*., 2025). It is strategically placed within a national development policy and the implementation of CBET is expected solve the persistent skills mismatches between training outcomes and labour market needs (Kiarie, 2025; Abdullah *et al*., 2025). The efficacy of CBET is pegged on the strength of assessment systems and requires valid, reliable, and standardized procedures that can measure higher-order practical competencies, which traditional instructor-centered assessment methods have been unable to meet (Barongo *et al*., 2024). The COVID-19 pandemic also revealed certain structural vulnerabilities in the sector, showing the lack of innovation, as well as an acute necessity for digitalization, especially in assessment (Miseda & Wanami, 2022; Orji & Perumal, 2024).

The use of ODeL can establish a tactical response towards these issues since it can lead to increased accessibility, flexibility, cost-effectiveness, and pedagogical innovation in TVET, particularly in less accessible and marginalized areas (Gaskell, & Mills, 2014; Omar *et al*., 2022). In Kenya, the factors driving the adoption of ODeL include infrastructure limits, accessibility, and continuity in case of an interruption (Katam & Otieno, 2021; Munene, 2023). However, empirical data show that there is a disparity in the implementation by region. Counties such as Vihiga and Bungoma are used as an illustration of the persistent hindrances of insufficient ICT, unreliable digital capacity internet connections, a lack of technical capacity, and weak policy backing, and resulting in the poor utilization of ODeL platforms (Avedi *et al*., 2024; Muiruri, 2023). At the national scale, ODeL is still more aspirational than functional, and this problem is reinforced by the lack of capacity in the instructional design and remote evaluation (Langat *et al*., 2022; Okumu & Kenei, 2022; Miseda & Wanami, 2022).

The AI offers a considerable source of opportunities to transform TVET assessment. Computer vision and other technologies allow objective assessment of practical tasks with the help of rubrics and visual images or videos (Kiarie, 2025; Jatmoko *et al*., 2025), machine learning and predictive analytics allow identifying at-risk learners and offering individual interventions (Yan *et al*., 2025; Feladi *et al*., 2025). The natural language processing helps to implement automated assessment of written and spoken communication (Sajja et al., 2024), and adaptive assessment engines are used to improve the accuracy of measurements and diminish assessment fatigue (Feladi *et al*., 2025). Empirical research illustrates better performance of AI-based models compared with conventional ones in the form of better predictive accuracy and assessment precision (Yan et al., 2025; Sajja *et al*., 2024).

The usage of AI is limited by ethical, infrastructural and human capacity issues. The issues of algorithmic bias, data privacy, and the digital inequalities

multiplier are also still important (Yan *et al*., 2025; Faisal *et al*., 2025; Barongo *et al*., 2024; Munyi *et al*., 2023; Harberts *et al*., 2025). A high degree of digital competency divide between TVET instructors is also going to be fueled by the fact that, especially in the rural locations, inadequate ICT training, and a lack in AI pedagogical proficiency negatively impact successful implementation (Harberts *et al*., 2025; Kiarie, 2025).

Theoretical Framework

The socio-technical systems approach and models of digital transformations form the basis of this review as the implementation of AI in TVET is seen as a systemic reform, rather than a technological modernization. The socio-technical theory highlights the interrelations among technological tools, institutional, infrastructural, and human systems, and that is why the effectiveness of AI-enabled assessment in Kenya is determined by infrastructure readiness, instructors' competency, and compatibility of governance (Kiarie, 2025; Harberts *et al.*, 2025). The digital transformation perspectives also note that the adoption of ODeL platforms implies not only a change in the technology but also in the structure and pedagogy (Langat et al., 2022; Miseda and Wanami, 2022). Also, the AI ethical systems highlight the issues of algorithmic bias, language constraints, and risks of data governance in the limited resource environments (Yan et al., 2025; Sajja *et al.*, 2024). The two approaches defined the AI-based assessment in TVET subsector as a socio-technical and policy change process.

Methodology

The systematic review design was used in this study because it was consistent with PRISMA 2020 guidelines (Page *et al*., 2021). It aimed to summarize peer-reviewed data on AI application in TVET assessment in ODeL systems of Kenya, as well as recommend a strategic model to incorporate it in a fair and scaleable way.

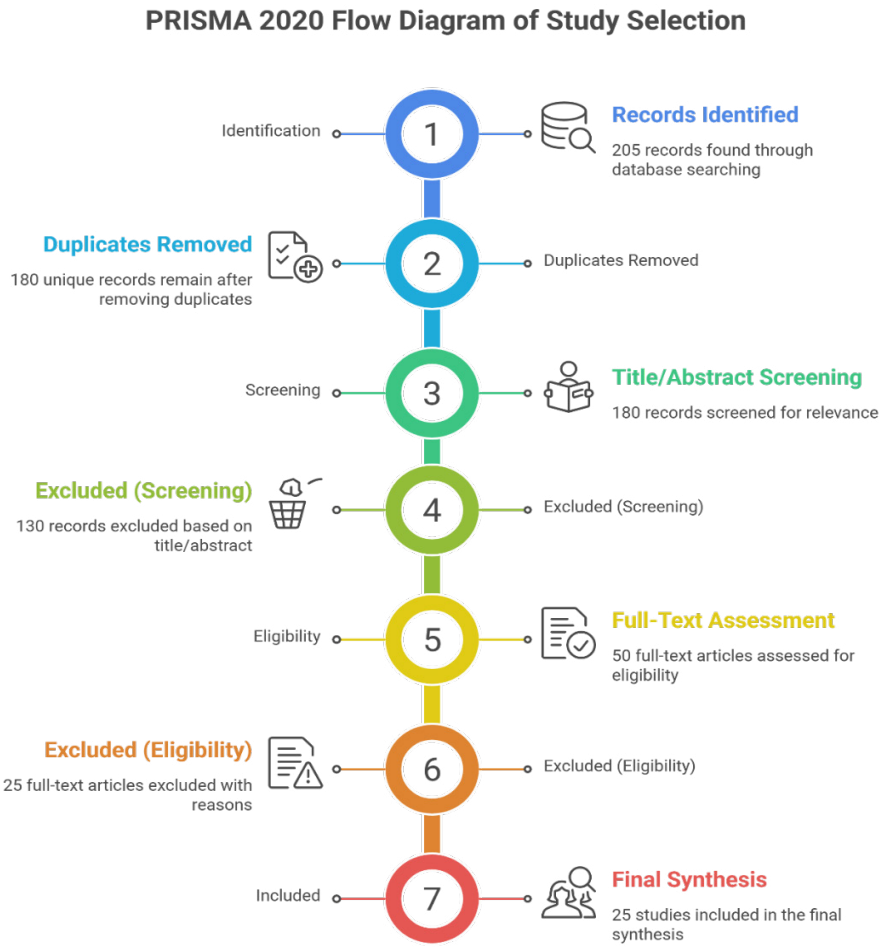
Google Scholar, Scopus, ERIC and Web of Sciences were searched thoroughly and included all the publications published in between January 2018 and December 2025. Search strings were made up of keywords and Boolean operators as follows: "Artificial Intelligence" AND "TVET" AND "Kenya" AND ("assessment" OR "skills evaluation") AND ("ODeL" OR distance learning). Included studies were also screened in terms of reference lists in order to identify other sources.

The eligibility criteria were peer-reviewed journal articles on the use of AI in TVET assessment in Sub-Saharan ODeL settings, and an empirical or analytical basis. The exclusion criteria included studies that were not in the area of TVET/ODeL and were not peer-reviewed, as well as those that were related to high-income settings only.

The screening was done in accordance with PRISMA 2020. In total, 205 records were found; 180 were left after the removal of duplicates. Among them, 130 were eliminated and 50 full-text articles were evaluated on the eligibility criteria. 25 studies met all the inclusion criteria. The exclusion criteria were absence of empirical evidence, no focus on TVET, or no assessment aspects related to AI. Figure 1 shows the PRISMA diagram that was employed in the selection process.

Figure 1

PRISMA 2020 Flow Diagram of Study Selection



Measurement and Coding Procedures.

The review assessed how AI technologies have been utilized in competency-based assessment in TVET with reference to four dimensions, namely: (1) nature of AI technology, (2) assessment role (diagnostics, feedback, prediction) (3) documented advantages, and (4) implementation issues.

Thematic analysis approach was utilized in coding. The first codes were created inductively through common patterns of the data and deductively out of the research questions. All the included studies were coded by two independent reviewers. The inter-rater reliability was evaluated with the help of the Cohen Kappa, the score was 0.82, which was a high level of agreement. Any disagreement would be settled out by discussion till agreement was achieved. This process would enhance the methodological soundness and respond to the questions of reviewer of transparency of coding.

Quality Appraisal

All the included studies were appraised based on the Critical Appraisal Skills Programme (CASP) checklist on clarity of the aims, methodological rigor, data validity and relevance to TVET/ODeL settings. Only studies which had met the minimum quality requirements were included in the synthesis.

Data Analysis and Data Extraction

The extraction of data covered the context of the study, AI technologies used, focus of assessment, benefits and limitations of the study, and policy/equity implications. Then thematic synthesis was used to reveal common technical, pedagogical and ethical themes across studies.

Findings and Analysis

The evidence of 25 peer-reviewed articles published within 2018-2025 was systematized in this systematic review. The results are provided in the form of integrated analysis, which emphasizes the relative strength of evidence, inconsistencies in the research results, the validity of the methods, and specific policy implications to the TVET industry in Kenya.

Digital Transformation and ODeL Adoption

It was demonstrated that ODeL increased the accessibility and flexibility of Kenyan TVET, especially at the time of COVID-19. The adoption of ODeL platforms is high, with Munyi *et al*. (2023) noting that the number of enrollments in these platforms increased by 42 percent in 2020-2021. Nevertheless, the opposite results were obtained: Avedi et al. (2024) indicated that systemic ICT failures lowered the level of participation of learners by 60% in Vihiga County, whereas Muiruri (2023) only stated that 28% of learners in Bungoma had a steady device access. Such differences highlight the fact that even though there were positive tendencies in the national adoption, regional inequalities compromised scalability.

Policy implication: Kenyan policy on TVET needs to be more regionalized whereby increased focus on rural infrastructure development is placed compared to the application of universal frameworks.

Artificial Intelligence in Competency-Based Assessment

The AI technologies were proved to have various applications: computer vision yielded 85 percent agreement with instructor-generated results (Kiarie, 2025), predictive analytics demonstrated better results over regression models (Random Forest $R^2 = 0.68$ vs. linear regression $R^2 = 0.41$) the advantage diminishes in small sampled context ($n < 300$), suggesting that model robustness is contingent upon data scale and contextual calibration (Yan *et al*., 2025), NLP showed high results in automated feedback (Sajja et al., 2024), and adaptive diagnostic engines reduced assessment fatigue by 35 percent (Feladi *et al*., 2025). Their contradictions were also observed: predictive models failed to work in small-sample studies (less than 300) (Yan *et al*., 2025), and NLP tools could not cope with multilingualism (Sajja *et al.*, 2024).

Policy implication: Kenyan policy on TVET should help localized calibration of AI tools whereby models are trained on Kenyan data to prevent the use of imported model.

Validity and Reliability of AI Measurement Approaches

- Computer vision systems were found to have good construct validity and poor reliability due to the low quality of images and connectivity (Kiarie, 2025; Jatmoko *et al*., 2025).
- Predictive analytics was always more predictively valid compared to regression, but the reliability depended on data quality and sample size (Yan *et al*., 2025).
- NLP tools had a high degree of reliability (accuracy), and was questioned as the validity due to the bias of the algorithm concerning the dialectal features (Sajja *et al*., 2024).
- Reliability was enhanced with adaptive diagnostic engines as they tracked learners in a consistent way, but the validity was compromised due to the use of datasets taken in high-income settings (Feladi *et al*., 2025).

In general, AI solutions were more reliable than traditional ones, yet lacked validity due to infrastructural gaps and contextual differences, and ethical issues.

Biases in Study, Sizes of Samples, and Methodological Flaws

There were a number of limitations that were brought forth through critical interrogation. Such biases as the use of urban or high-income data, which can lead to unfair transferability (Yan *et al*., 2025; Harberts *et al*., 2025), and NLP modeling biases (Sajja *et al.*, 2024) were employed. Sample sizes were usually small ($n < 300$) which constrained external validity and made overfitting an issue. Limitations in the methodology were that it did not track the results across the long term, simulations not real classroom settings, and unreliability measures were not consistently reported (Feladi *et al*., 2025).

Policy implication: These shortcomings have distinct policy implications on Kenyan TVET policy by highlighting the role of investment in large scale, longitudinal, context sensitive research prior to national implementation of AI-enabled systems of assessment.

Results and Discussions

This paper puts AI-based evaluation in a socio-technological change model that is specific to the Kenyan TVET system. In contrast to the models of global digital transformation, which presuppose the stabilized infrastructure and institutional preparedness (Grech and Camilleri, 2020; Mallik and Gangopadhyay, 2023), the situation in Kenya proves that infrastructural imbalances, uneven ODeL implementation, and limits in the capacity of instructors determine technological innovation (Langat *et al*., 2022; Muiruri, 2023). In line with the socio-technical systems theory, successful AI consumption involves digitally tailored infrastructure, competence in pedagogies, and governance systems working together instead of technology in isolation (Kiarie, 2025; Harberts *et al*., 2025). The results thus reconstruct AI evaluation as an organization reformation process that is entrenched in the institutional, social and policy frameworks. Contextual calibration, equity-based protective measures and long-term alignment of institutions are the keys to success in effecting transformation in resource-constrained settings so that AI can enhance competency-based education and not replicate the existing structural disparities in the Kenya TVET ecosystem.

Kenyan TVET Policy of AI Operationalization.

The evidence is unique in its ability to inform the Kenyan policy on TVET in more than just general recommendations that can be found in global models. First, the difference in the ODeL adoption and AI performance between rural and urban settings points to the fact that policy should focus on region-specific investments into infrastructure. The allocation of resources to overcome the connectivity gaps, device access, and technical support in underserved counties should not be assumed when national strategies are developed.

Second, the comparative research of AI measurement strategies indicates that localization of AI models during their calibration is of necessity. NLP tools and predictive analytics proved to be very reliable in the controlled setting, but failed to work in a small sample or multilingual conditions. The Kenyan policy should make the use of local datasets to train AI systems a requirement hence the relevance in culture and language. This step in the room would curb the bias in algorithms and enhance the external validity.

Third, the questioning of study biases and methodological flaws indicated that most of the existing evidence is informed by small-scale, short-term, or simulated studies. Policy must also encourage longitudinal, large-scale and context-sensitive research in order to support the evidence base. This may be modelled by forming partnerships that involve the TVET institutions, government agencies, and industry stakeholders such that the adoption of AI is not based on pilot studies only.

Fourth, there are some ethical issues like data privacy and equity risks, which need formal regulation systems. There should be a clear guideline on data governance, algorithmic transparency and fair access. In the absence of these protective measures, AI implementation will only tend to increase existing disparities and not lessen them.

Artificial Intelligence-based TVET Evaluation Strategic Model

Based on these results a strategic plan of Kenya should entail:

- Infrastructure invested prioritized in the rural and marginalized areas to provide equality in ODeL uptake.
- Local AI calibration with Kenyan data to enhance validity and bias. TVET to come up with a national AI model trained on locally.
- TVET instructor capacity building based on digital and artificial intelligence literacy to promote pedagogical integration.
- Longitudinal research studies to produce strong evidence on AI application in the real-life classroom setting.
- Ethical and legal measures to safeguard learner information, work towards transparency, and create equity.

With operationalization of these steps, Kenya can pass the stage of descriptive utilization of AI technologies to context-sensitive, evidence-based, and policy-congruent strategy. This will help to guarantee that AI-driven assessment reinforces competency-based education, promotes a fair flow of access, and plays a direct role in the implementation of national development in line with Vision 2030.

Limitations of the Review

This review has limitations. The searches could have overlooked non-indexed or non-English studies. The use of both conceptual and empirical papers creates variability in the level of evidence. The AI evolution is rapid, which implies that new developments might be missed. There are high chances of publication bias on positive results. The Kenyan emphasis restricts generalization to much different contexts.

Conclusions and Recommendations

Conclusion

The systematic review included 25 articles on AI-based assessment in TVET ODeL systems of Kenya. The results indicated that AI technologies such as computer vision, predictive analytics, natural language processing, and adaptive diagnostics, among others, had a steady improvement in the aspects of reliability and efficiency over traditional methods. However, due to infrastructural shortcomings, limited sample sizes, algorithm bias and use of high-income datasets, validity was limited. Several contradictions arose, as predictive models were no longer effective in small sample and NLP tools in multilingual environments. Additional weaknesses of the study that also reduced generalizability were methodological weaknesses such as short-term designs and simulated settings.

These understandings are also distinctive indicators of Kenyan policy in the field of TVET, as they reveal the necessity of regional-specific infrastructural investments, training AI models locally, instructor capacity building, and longitudinal and context-aware research. There is also a need to have ethical protection concerning data control and fairness. The operationalization of these measures will help Kenya go beyond generic world recommendations and focus on a proper strategic, evidence-based framework to enhance competency-based education and further the Vision 2030 objectives.

Recommendations

The following are the suggested recommendations based on the review results in order to promote effective, equitable and sustainable incorporation of Artificial Intelligence (AI) into TVET assessment in ODeL systems in Kenya.

1. Invest in Digital Infrastructure that is context sensitive

The government and the institutions must increase dependable connections, cloud computing, and access to devices, particularly in the rural and underserved areas, to decrease digital discrepancy and permit scaling AI-aided evaluation.

2. Localize AI Systems Using Kenyan Data

The AI tools must be trained using local datasets which are representative of Kenyan languages, curricula and workplace realities to enhance validity, cultural relevance, and minimize bias of the algorithm.

3. Build Instructor Capacity

To make sure that technology complements, but not replaces, pedagogical expertise in competency-based assessment, TVET instructors should be provided with digital and AI literacy skills at all times.

4. Develop Ethical and Data governance Systems

There must be explicit rules regarding data privacy, transparency, and responsibility to protect information about learners and stimulate confidence in AI-based assessment systems.

5. Foster Long-term research, Practice-Based Research

Joint research by TVET institutions, industry, donars and government should be done to test AI applications in real learning contexts to produce evidence on sustainable scaling.

6. Embraced Hybrid Evaluation models

The implementation of AI in the institutions should be done, in stages, and in a blended manner whereby automated analytics assists the instructors in their professional judgment (Langat *et al.*, 2022; Miseda & Wanami, 2022).

On the whole, digital transformation of TVET assessment requires a context-sensitive approach, which involves coordinated investment into infrastructure, human capacity, ethical regulation, and applied research (Kiarie, 2025; Ghosh & Ravichandran, 2024).

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Screen Readers Usability in Developing Digital Literacy for Trainees with Visual Impairment in Technical and Vocational Education and Training, Kenya

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Abstract

Screen readers significantly enhance the operational independence of Trainees with visually impaired. According to the National Federation of the Blind, 94% of blind professionals consider screen readers as essential for job performance. Digital literacy is a critical vocational skill for Trainees With Visual Impairments (TWVI) in TVET system. Approximately 2.2% of Technical and Vocational Education and Training (TVET) trainees' population is visually impaired, yet over 65% face barriers in accessing TVET programs with only 50% completion rates. This is despite USD 1 million in assistive technology investments through AfDB projects. This study investigated role of screen readers in developing digital literacy among TWVI in special TVET institutes in Kenya. The study targeted 220 trainees and 20 trainers using census sampling selecting 198 trainees and 18 trainers. Data was collected through questionnaires and observation schedules. Reliability coefficients of 0.87 trainers questionnaire, 0.84 for trainees' questionnaire and 0.77 for observation schedule. The findings showed that screen reader access strongly supported independent task completion and pacing with sighted peers (mean=3.75-3.94). However, outdated software (mean= 3.70) and insufficient trainer preparation (mean = 2.39) were noted as challenges. Most trainers (77.8%) acknowledged high learner engagement and affirmed the role of screen readers in supporting computer conceptual understanding although curriculum integration remained so limited (mean = 2.83). The Observational data indicated strong proficiency in basic skills (mean > 4.0) but lower competence in advanced tasks such as spreadsheet use. This research highlighted the screen readers potential in equitable vocational training although identifying systemic limitations. The insights offered are necessary for trainers and policymakers to enhance inclusivity in TVET.

Keywords: Screen Reader, Assistive Technology, Visual Impairment, Digital Literacy

Introduction

Globally, vision impairment affects 2.2 billion people (WHO, 2019) with Africa bearing the highest regional burden. In Kenya, approximately 1.2 million people lives with visual impairment representing about 2.2% of the population. Despite the mentioned statistics, trainees with visual impairments (TWVI) remain significantly underrepresented in Technical and Vocational Education and Training (TVET) institutions. Out of 389,962 trainees enrolled in public TVET in 2024, only a small proportion of these had visual impairment accounting for less than 1%**.** This scenario is closely linked to barriers in accessing digital learning environments, where assistive technologies play a critical role. Screen readers such as JAWS and NVDA bridge this gap by enabling TWVI to access digital vocational skills necessary for participation in an ICT-driven economy (Kirboyun, 2020). According to Kelly & Smith 2011, screen readers directly support academic success, independence and employability. Research has shown that only 23% of TWVI in Kenya possess basic digital skills largely due to limited access to assistive technologies and structured training (KISE, 2022). International evidence shows that screen-reader use improves engagement but that inaccessible digital content and inadequate training remain major barriers (WebAIM, 2017; AFB, 2018). This study examined the usability of screen readers in developing digital literacy among TWVI in Kenyan TVET institutions using a quantitative research approach.

Statement of the Problem

African Development Bank Skills and Employability Programme (2019–2024) invested over USD 1 million in assistive Technology (AT) in TVET institution in Kenya yet national TVET enrolment data for April 2024 show that only 4.5% of trainees were persons with disabilities and just less than 1% were visually impaired. This underrepresentation persists despite Kenya inclusive disability legislative framework including Constitution of Kenya (2010), Persons with Disabilities Act (2025), National Disability Policy (2006), TVET Act Cap. 210A and more so commitments to Sustainable Development Goal 4 which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. In addition, completion rates for TWVI remain below 50% with the majority facing infrastructural, pedagogical and technological barriers (KISE, 2022). Digital literacy, which is a prerequisite across modern vocational disciplines, remains particularly unattainable for TWVI with only 23% demonstrating basic proficiency (KISE, 2022). Limited access to functional screen readers such as JAWS, NVDA, Narrator and Voiceover, lack of trainer preparedness really undermine inclusive learning. It was of great concern that 95% of TWVI were into theory based or non technical programmes. This restricted their participation in high demand trades such as electrical installation,

automotive engineering, ICT, agribusiness and construction. Regional studies have explored general assistive technology adoption. This leaves a gap in empirical evidence on screen reader usability in fostering digital literacy and enabling practical engagement in Kenya TVET sector. This data remained scarce undermining targeted reforms in curriculum implementation, instructor training and infrastructure development. Therefore, this study investigated the usability of screen readers in developing digital literacy among TWVI in Kenyan TVET institutions, focusing on access, utilization, pedagogical integration and their influence on skill acquisition and participation in practical training.

Research Objective

The main objective of this study was to assess Trainees and Trainers perspective on the use of screen readers in developing Digital Literacy for Trainers With Visual Impairment (TWVI). The specific objectives of the study were to:

i. Determine trainees' views on use of screen readers in developing digital literacy skills;
ii. Determine trainers' views on use of screen readers in developing digital literacy skills;
iii. Identify trainees' observations on developing digital literacy.

Methodology

Research Design

Descriptive survey design was adopted.

Table 1

Target Population

Group	Target population(N)	Sample size(n)	Percentage (%)
Trainers	20	18	90
Trainees	220	198	90

Research Instruments

The research data was obtained by administering questionnaires to Trainers and Trainees as well as observation schedules for trainees.

Data Analysis Techniques

This study adopted a quantitative data analysis technique to analyse collected data using SPSS to generate descriptive statistics such as frequencies, percentages and means.

Results and Discussion

Table 2

Response Rate

Respondent	Population (N)	Sample (n)	Actual Responses	Response Rate (%)
Trainees	220	198	188	95
Trainers	20	18	18	100

Table 3.

Demographic information of the Respondents: TWVI (n=188)

Demographic Information	Category	F	%
Gender	Male	107	56.91%
	Female	81	43.09%
		188	**100%**
Age	16-24 years	105	55.85%
	25-30 years	54	28.72%
	31-35 years	23	12.23%
	36-39 years	4	2.12%
	>40 years	2	1.08%
		188	**100%**
Level of Visual impairment	Total Blind	167	88.83%
	Low Vision	21	11.17%
		188	**100%**
Vocational Courses	Arts/ Business	182	96.81%
	Engineering / Technology	6	3.19%
		188	**100%**

A total of 188 TWVI participated in the study, with 56.91% male and 43.81% female respondents, indicating more male than female trainees. Badr et al. (2007) found that females with visual impairments often face greater difficulties coping with disability, contributing to their lower representation. Similarly, Andiema *et al.* (2021) also reported in their research higher male admissions in vocational colleges indicating the fact that female trainees encounter frequent barriers such as marriage and maternity-related interruptions. These findings suggest a persistent gender gap in TVET enrolment influenced by social, cultural and institutional factors that limit access for female TWVI.

Majority of the trainees 55.85% (105) were aged between 16–24 years followed

by 28.72% (54) in the 25–30 years age groups. Only 15.43% (29) were over 30 years. The study findings indicate that most trainees joined vocational training immediately after secondary education and that youthful population was actively seeking skills for employability. This distribution may reflect institutional admission patterns and it underlines the need for assistive technology tailored for total blindness. An overwhelming majority 96.28% (182) were enrolled in Arts/Business-related courses, while only 3.19% (6) were in Engineering/ Technology fields. The study findings are in line with Palan *et al*, (2020) that low enrolment in technology or engineering-based courses were due to exclusion from science and mathematics in early education, inadequate support systems, inaccessible teaching practices, and limited work opportunities.

Table 4

Trainees' views on Use of Screen Readers in developing digital literacy Skills (n=188)

Statement	SD f	D f	N f	A f	SA F	Total	Mean	Std. Deviation
Access to screen reader	3	**7**	1	169	8	188	3.91	.57
Regular Use of screen reader	2	**7**	42	136	1	188	3.67	.60
independently complete computer-based tasks using screen reader	0	23	23	120	22	188	3.75	.81
keep pace with sighted trainees	6	11	19	105	47	188	3.93	.93
screen reader software is outdated	12	38	6	70	62	188	3.70	1.29
More support needed	4	36	7	75	66	188	3.86	1.15
More investment in accessible ICT tools	0	11	14	56	107	188	4.37	.85
Overall mean							**3.88**	**0.891**

Table 4 shows the role of screen readers as a critical assistive technology (AT) in vocational training for TWVI. A total of 188 trainees participated in the survey. The overall mean scores of screen readers in acquisition of computer literacy skills (mean=3.88) indicated that the majority of the trainees agreed that use of screen readers greatly contributed to the acquisition of computer literacy skills. More investment in screen readers in accessing ICT tools was highly preferred by the majority of trainees (Mean=4.37) with relatively lowest variation (S.D=0.89). In contrast, regular use of screen readers was recorded the lowest mean (mean = 3.67) suggesting that while the importance of screen readers is widely recognized, consistent utilization remains a challenge. The levels of agreement were high regarding accessibility (89.9%) and ability to pace learning with sighted peers (84.5%). In comparison, lower agreement

level on regular usage and variability in responses point to barriers in sustained integration potentially related to outdated software and inadequate institutional support. On the need for increased investment, implied that existing assistive technology infrastructure may be insufficient to fully support skill acquisition and employability outcomes for TWVI. These revelations are consistent with a report of research conducted by (Haneefa *et al.*, 2014) which concluded that widespread computer literacy among visually impaired learners using screen readers, particularly JAWS and Microsoft Office. Others like Basantes *et al.*, 2018 confirmed that screen readers provide blind students autonomy in digital communication and information access. While Pankyes *et al*., (2025) specifically showed improved academic performance, with screen reader users experiencing significant mathematics achievement gains. However, challenges exist, including Tipi *et al.*, (2023) noted technical difficulties and inaccessible digital content thus screen readers were transformative but not a perfect assistive technology for computer literacy skill development

Table 5

Trainers' views on Use of Screen Readers in developing digital literacy Skills(n=18)

Statement	SD	D	N	A	SA	Total	Mean	Std. Deviation
	F	f	f	f	f			
Familiarity with screen reader software	3	5	1	1	8	18	3.33	1.68
Adequate training received	2	**7**	9	0	0	18	2.38	.69
Regular use of screen readers when teaching	0	9	9	0	0	18	3.00	1.02
Integration into computer curriculum.	3	6	0	9	0	18	2.83	1.24
Active engage TWVI in supported lessons	3	0	0	1	14	18	4.27	1.52
Understand key computer concepts using screen readers	0	0	0	18	0	18	4.00	.00
updated and functional screen reader	0	4	0	9	5	18	3.83	1.09
Inclusive digital learning through screen reader integration.	0	0	0	14	4	18	4.22	.42
Challenges hindering effective use	0	9	0	6	3	18	3.16	1.24
Need for more training to enhance screen reader use	0	3	4	4	7	18	3.83	1.15
Overall mean							**3.485**	**1.005**

Table 5 presents the perspectives of trainers regarding the use of screen readers in developing digital literacy among TWVI. A total of 18 trainers participated in the survey. The report indicates mixed views among trainers regarding the contribution of screen readers to computer literacy acquisition with about 50% reporting neutral or negative perceptions. The variability of responses was notable particularly regarding familiarity with screen readers (SD = 1.68) indicating inconsistent trainer experience. Despite reservations about implementation, trainers strongly acknowledged positive learner outcomes. High levels of agreement were reported in relation to learner outcomes with 88.9% of trainers affirming screen readers foster engagement and 100% recognizing their role in supporting conceptual understanding**.** On trainer capacity, gaps were evident with the lowest mean score recorded for adequate training (mean = 2.38) and limited curriculum integration (mean = 3.00) which was supported by only 38.9% agreement. Additionally, majority of trainers (72.2%) emphasized the need for further professional development. Overall, the findings indicated a clear disparity between recognition of learner benefits and trainer preparedness. Screen readers are widely perceived as effective in enhancing engagement and conceptual understanding among TWVI though inadequate trainer training and weak curricular integration negatively affect their sustained use in instructional practice.

Table 6

Trainees observations on developing digital literacy (n=188)

Statement	SD	D	N	A	SA	Total	Mean
	f	f	f	f	F		
Basic Computer Operations	5	12	21	67	80	185	4.04
Keyboarding Skills	3	8	18	71	85	185	4.16
File Management	10	15	30	65	65	185	3.8
Word Processing	12	19	33	61	60	185	3.69
Spreadsheets	22	27	46	52	38	185	3.26
Internet Navigation	11	17	31	64	62	185	3.74
Email Communication	15	20	39	60	51	185	3.55
Operating screen readers (JAWS/NVDA)	2	5	10	63	105	185	4.36
Online Safety and Ethics	20	26	37	58	44	185	3.38
Use of Educational Software and Platforms	14	22	32	60	57	185	3.61
Overall mean							**3.759**

Observational data on role of screen readers in developing computer literacy skills among trainees with visual impairments (n = 185) is presented in Table

6 with overall proficiency (Mean=3.76) across assessed skill areas. Highest performance was observed in operating screen readers (mean = 4.36) while the lowest was recorded in spreadsheet applications (mean = 3.26). More trainees (56.8%) demonstrated high proficiency in assistive technology use with 45.9% showing mastery of basic keyboarding skills. Screen readers therefore effectively support the acquisition of foundational digital skills by enabling TWVI to navigate computer skills tasks independently. Comparatively, lower performance in advanced applications particularly spreadsheets suggest weakness in screen reader use to more complex computing tasks. The challenges are likely to be attributed to software compatibility and insufficient advanced digital skills. These findings indicate screen readers expand TWVI functional capabilities by enabling participation and inclusion in digital vocational learning though gaps in advanced competencies indicate that these capabilities are not fully realized limiting preparedness for technology driven vocational skills.

In summary, this study clearly indicated across trainee opinions, trainer perspectives and observational data that screen readers emerge as critical enablers of digital literacy for trainees with visual impairments (TWVI) within TVET institutions. Trainees consistently reported positive contributions of screen readers to computer literacy, independent task completion and ability to pace learning with sighted peers while observational findings confirmed strong proficiency in foundational skills such as screen reader operation and keyboarding. Trainers similarly acknowledged high levels of learner engagement and conceptual understanding. Despite this learner centred gains, trainers and trainees reveal persistent systemic constraints. Regular use and curricular integration of screen readers remain limited; trainer preparedness is inadequate and performance declines in advanced applications such as spreadsheets. This evidence suggests that while screen readers effectively expand TWVI functional skills, full potential is constrained by insufficient institutional investment, limited professional development and weak integration into vocational curricula. Therefore, it is necessary to address the gaps to enable progression from basic digital competence to advanced vocational relevant skills.

Conclusions and Recommendations

Conclusion

In conclusion, this study endorses Screen readers as vital tools for acquiring digital literacy among TWVI in Kenyan TVET institutions. The trainees demonstrate strong motivation and positive attitudes though outdated software; limited trainer capacity and weak curriculum integration continue to constrain its effective use.

Recommendations

The recommendations based on this research output are as follows:

1. Update screen reader software (JAWS, NVDA) in computer laboratories
2. Provision of frequent practical training and capacity building for trainers and trainees on screen reader functionality
3. Digital literacy TVET curricula to integrate screen reader skills to accommodate TWVI at introductory level

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Institutional Readiness and Ethical Governance for AI and Blockchain Adoption in TVET: A Case Study of Kericho National Polytechnic

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Abstract

Kenya's Technical and Vocational Education and Training (TVET) sector faces growing pressure to adopt emerging digital technologies responsibly. Artificial Intelligence (AI) and Blockchain offer genuine opportunities to improve transparency, learner engagement, and institutional efficiency; yet many institutions remain constrained by inadequate infrastructure, weak governance frameworks, and limited staff capacity. Grounded in the Technology Acceptance Model (TAM), this study examined the foundational building blocks necessary for ethical and responsible implementation of AI and Blockchain, using Kericho National Polytechnic as a case study. A convergent parallel mixed-methods design was employed, combining structured Likert-scale questionnaires with open-ended qualitative responses gathered from staff, trainees, alumni, and external partners. Of 120 questionnaires administered, 88 were returned and usable, representing a response rate of 73.3%. Readiness was operationalized through TAM-based composite indices perceived usefulness and perceived ease of use whilst ethical awareness was captured via a five-item scale and governance maturity through a three-item policy-alignment indicator. Cronbach's alpha coefficients of 0.78 and 0.81 confirmed acceptable instrument reliability. Three null hypotheses were tested using Chi-square analysis. All three were rejected, confirming that prior digital exposure, infrastructure adequacy, and the strength of ethical governance frameworks each significantly influence adoption readiness and intent. Qualitative themes highlighted persistent concerns around data privacy, accountability gaps, and regulatory uncertainty regarding Blockchain. Drawing inductively on both data strands, four building blocks for responsible adoption were identified: institutional preparedness, ethical governance, continuous capacity development, and sustained infrastructure investment. It is recommended that TVET institutions enforce digital ethics policies, strengthen data governance, invest in staff competencies, and build secure technological systems to support equitable and trustworthy digital transformation.

Keywords: AI, Blockchain, TVET, Governance, Readiness

Introduction

Kenya's TVET sector is under increasing pressure to modernize through digital technologies, with Artificial Intelligence (AI) and Blockchain occupying a prominent place in national reform efforts. Both technologies are widely associated with gains in institutional transparency, learner engagement, and administrative efficiency (Ateeq et al., 2024; UNESCO, 2021). At the national level, Kenya has moved in this direction through the AI National Skilling Initiative, which targets trainees and instructors alike, and through the establishment of AI-enabled TVET centres of excellence for examination management (Omollo, 2025; Lawi, 2025).

However, enthusiasm for these technologies has not always been accompanied by the necessary institutional groundwork. AI systems can embed bias, compromise privacy, and operate in ways that are difficult to contest (Yan *et al*., 2023; UNESCO, 2021). Blockchain, despite its potential for credentialing and records integrity, faces barriers including regulatory gaps, governance weaknesses, and limited technical understanding among institutional staff (Mohammad & Vargas, 2022; Luo et al., 2023). The challenge for Kenyan TVET institutions is therefore not simply one of technological access, but of readiness to adopt responsibly. This study sought to identify the foundational building blocks that determine whether such adoption can be both effective and ethical.

Defining Key Concepts

Within this study, Responsible AI denotes the deployment of AI systems that actively uphold data privacy, fairness, accountability, transparency, and human oversight across TVET operations. Ethical Blockchain refers to the application of distributed ledger technology in ways that protect data integrity, support regulatory compliance, and ensure equitable access — particularly in credentialing, institutional records, and financial transactions. These definitions informed instrument design and hypothesis framing.

Theoretical Framework

The study is grounded in Davis's (1989) Technology Acceptance Model (TAM), which holds that perceived usefulness and perceived ease of use are the primary determinants of technology adoption intention. These constructs were operationalized as the core readiness indices. Since original TAM does not account for ethical or governance dimensions, the framework was extended to incorporate trust, risk perception, and policy clarity as moderating variables an adaptation consistent with emerging literature on ethically sensitive technology

adoption in educational settings (Ateeq *et al*., 2024).

Problem Statement

Despite considerable momentum behind AI and Blockchain adoption in Kenya's TVET sector, institutions remain ill-equipped for the ethical and governance dimensions of this transition. Infrastructure deficits, low digital literacy, and the absence of coherent institutional policies present concrete barriers to implementation (Yan *et al.,* 2023; Sibanda, 2025). Blockchain adoption is further hampered by unclear governance structures and limited regulatory understanding (Mohammad & Vargas, 2022; Luo *et al.,* 2023). The national policy environment, though evolving as evidenced by the Ministry of Education's (2025) draft national TVET policy has not yet translated into institutional-level readiness at most colleges. Without structured ethical and governance frameworks, institutions risk deploying technologies in ways that compromise learner rights, accountability, and public trust. This study addressed that gap by investigating the building blocks needed for responsible adoption at Kericho National Polytechnic.

Research Objectives

General Objective

To examine the essential building blocks for embedding responsible and ethical AI and Blockchain frameworks in Kenya's TVET institutions, drawing on evidence from Kericho National Polytechnic.

Specific Objectives

The study pursued the following specific objectives:

i. To assess stakeholder readiness and perceptions regarding AI and Blockchain adoption among staff, trainees, alumni, and external partners.

ii. To identify infrastructural, technical, and digital literacy challenges that affect implementation.

iii. To examine the ethical, governance, and regulatory considerations relevant to responsible technology deployment.

iv. To propose evidence-based strategies for sustainable, inclusive, and accountable integration of AI and Blockchain in TVET institutions.

Research Hypotheses

The following null hypotheses were formulated and subjected to statistical testing:

H_{01}: Prior exposure to digital technologies does not significantly influence stakeholder readiness to adopt AI and Blockchain.

H_{02}: Infrastructural, technical, and digital literacy challenges do not significantly affect the adoption of AI and Blockchain.

H_{03}: Ethical, governance, and regulatory frameworks do not significantly influence the responsible adoption of AI and Blockchain.

Methodology

Research Design

A convergent parallel mixed-methods design was adopted, enabling simultaneous collection of quantitative and qualitative data, which were subsequently merged at the interpretation stage (Creswell & Creswell, 2018; Fetters *et al.*, 2013). This design was suited to the study's dual aim of measuring readiness and understanding the contextual ethical concerns that shape it.

Population and Sampling

The total institutional population at Kericho National Polytechnic was estimated at approximately 480 individuals. However, applying the eligibility criterion of direct involvement in digital technology use or TVET programme delivery which excluded learners in non-digital programmes and external stakeholders with no active institutional engagement, the accessible and eligible target population was established at 172 individuals. Sample size was determined using Yamane's (1967) formula at a 95% confidence level with a 5% margin of error:

$$n = N \div (1 + Ne^2) = 172 \div (1 + 172 \times 0.0025) \approx 120.6$$

This yielded a required sample of 121, approximated to 120 for ease of administration. This confirms that the study sample of 120 is statistically sufficient and representative of the eligible population. Stratified purposive sampling produced the following stratum allocation: administrative staff (n = 36, 30%), trainees (n = 48, 40%), alumni (n = 24, 20%), and external stakeholders (n = 12, 10%). Selection within strata was based on direct involvement in digital technology use or TVET programme delivery.

Data Collection Instruments

A hybrid instrument combined structured Likert-scale items with open-ended questions. Three sub-scales operationalized TAM constructs: Perceived Usefulness (four items on task improvement), Perceived Ease of Use (four items on effort expectancy), and Adoption Readiness (three items on a five-point scale). Ethical awareness was captured via five items covering data privacy, fairness,

accountability, transparency, and human oversight; governance maturity was measured through three policy-alignment items. A pilot test with 15 participants returned Cronbach's alpha of 0.78 (readiness) and 0.81 (ethics awareness). Surveys were administered over four weeks online and in person, supplemented by review of institutional policy documents.

Data Analysis

Quantitative data were processed in SPSS, with descriptive statistics summarizing readiness and barrier variables. Chi-square tests of independence examined each null hypothesis at $\alpha = 0.05$. Qualitative data underwent thematic analysis following Braun and Clarke's (2021) six-phase framework; intercoder agreement between two independent analysts yielded Cohen's kappa of 0.76. Mixed-methods integration used a joint display approach as recommended by Fetters et al. (2013).

Ethical Clearance

Ethical clearance for this study was obtained from the National Commission for Science, Technology and Innovation (NACOSTI) in accordance with Kenya's Science, Technology and Innovation Act (Cap. 250). Institutional authorisation was subsequently granted by Kericho National Polytechnic. Informed consent was secured from all participants prior to data collection, and all data were anonymised and securely stored in accordance with applicable ethical standards (NACOSTI, 2020; UNESCO, 2021).

Results and Discussions

Response Rate

Of 120 questionnaires distributed across the four stakeholder groups, 88 were returned and usable, yielding a response rate of 73.3% considered robust for social science research (Flick, 2020). Table 1 summarizes the response data.

Table 1

Questionnaire Response Rate

Item	Description	Value
Questionnaires distributed	Staff, trainees, alumni, external stakeholders	120
Questionnaires returned	Completed and usable	88
Response rate	(88 ÷ 120) × 100	73.3%

Demographic Profile

Respondents comprised administrative staff (30%, n = 26), trainees (40%, n = 35), alumni (20%, n = 18), and external stakeholders (10%, n = 9). By gender, 52% were male (n = 46) and 48% female (n = 42). Sixty-five per cent (n = 57) reported prior exposure to digital technologies, including digital finance tools or cryptocurrency platforms.

Stakeholder Readiness and Perceptions of AI and Blockchain Adoption;

Descriptive Statistics

Table 2 presents means and standard deviations for the key TAM constructs and related variables.

Table 2

Descriptive Statistics for Key Variables

Variable	n	Mean (1–5)	SD	Observation
Readiness prior digital exposure	57	4.21	0.61	High readiness among experienced respondents
Readiness limited digital exposure	31	3.08	0.74	Moderate; notable gap compared to experienced group
Perceived usefulness of AI & Blockchain	88	4.09	0.68	Rated highly for institutional and teaching use
Perceived ease of use	88	3.62	0.79	Moderate; constrained by infrastructure and skill gaps
Ethical awareness score	88	3.44	0.83	Moderate; notable gaps around data privacy
Governance maturity (policy-alignment)	88	2.98	0.92	Below average; weak institutional policy frameworks

Respondents with prior digital experience scored notably higher on readiness ($M = 4.21$, $SD = 0.61$) than those without ($M = 3.08$, $SD = 0.74$). Governance maturity recorded the lowest mean across all constructs ($M = 2.98$, $SD = 0.92$), indicating a substantial gap in institutional policy preparedness.

Hypothesis Testing

H_{01}: Prior Digital Exposure and Adoption Readiness

A Chi-square test of independence revealed a statistically significant association between prior digital exposure and adoption readiness ($\chi^2(1, N = 88) = 12.87$, $p = .000$, Cramér's $V = 0.38$). H_{01} is rejected. Respondents with prior digital experience were considerably more ready to adopt AI and Blockchain than those without, with a moderate effect size indicating practical as well as statistical significance.

The significant association between prior digital exposure and adoption readiness ($\chi^2 = 12.87$, $p < .05$) aligns with patterns reported in comparable African contexts (Ateeq et al., 2024; Tonui et al., 2025). The readiness gap between experienced ($M = 4.21$) and less-experienced respondents ($M = 3.08$) confirms TAM's central premise that prior familiarity reduces perceived risk and raises adoption intent (Davis, 1989). Practically, this means that Kericho National Polytechnic cannot assume a uniform readiness baseline; structured orientation programmes targeting less-exposed staff and trainees are a prerequisite for any broader technology rollout.

Infrastructural, Technical, and Digital Literacy Challenges

H_{02}: Infrastructure, Digital Literacy, and Adoption

A Chi-square test found a significant association between infrastructure adequacy and adoption readiness ($\chi^2(2, N = 88) = 9.43$, $p = .009$, Cramér's $V = 0.33$). H_{02} is rejected. Sixty-eight per cent of respondents ($n = 60$) identified poor connectivity, insufficient devices, and limited digital skills as the foremost barriers to adoption. Table 3 details the specific barriers reported.

Table 3

Infrastructure Barriers Identified by Respondents

Barrier	Frequency (n)	Percentage (%)
Absence of AI/Blockchain training programmes	63	71.6%
Limited internet connectivity	61	69.3%
Low digital literacy among staff	58	65.9%
Insufficient devices and equipment	55	62.5%
Inadequate cybersecurity systems	47	53.4%

The rejection of H_{02} reinforces what has long been discussed in the literature on Sub-Saharan African TVET institutions: that physical and human infrastructure constraints are central rather than peripheral to the adoption challenge (Sibanda, 2025; UNESCO, 2021). The finding that 71.6% of respondents cited absent training programmes as the most pressing barrier underscores that willingness to adopt technologies is not sufficient without structured opportunities to build the relevant competencies. The moderately low perceived ease of use score ($M = 3.62$) further reflects how poor infrastructure reduces confidence in technology usability, consistent with TAM predictions (Davis, 1989).

Ethical, Governance, and Regulatory Considerations

H_{03}: Ethical Governance Frameworks and Responsible Adoption

A Chi-square test examining the association between governance awareness and responsible adoption intent was statistically significant ($\chi^2(2, N = 88) = 11.24$, $p = .004$, Cramér's $V = 0.36$). H_{03} is rejected. Respondents who scored higher on governance maturity were significantly more likely to express responsible adoption intent, confirming that the presence of ethical policy frameworks makes a measurable practical difference.

Qualitative Findings

Ethical Concerns

Thematic analysis produced four ethical themes. Data Privacy and Confidentiality was raised by approximately 72% of participants, who cited concerns about unauthorized access and inadequate consent processes. Fairness and Non-Discrimination highlighted the risk that AI-driven assessments might disadvantage certain learner groups if not carefully calibrated. Accountability and Transparency emerged as a demand for explainable AI decisions, particularly where outcomes affect learner progression. Human Oversight was regarded as non-negotiable in assessment and credentialing contexts.

Blockchain: Perceived Benefits and Reservations

Table 4

Stakeholder Perceptions of Blockchain: Perceived Benefits and Reservations

Perception Category	Frequency (n)	Percentage (%)
Perceived Benefits		
Secure certification and credential verification	60	68.2%
Reliable digital transactions	48	54.5%
Traceable institutional records	43	48.9%
Reservations and Concerns		
Unclear regulatory environment	54	61.4%
High implementation costs	50	56.8%
Risk of misuse of stored data	38	43.2%

Note. N = 88; multiple responses permitted.

As shown in Table 4, Blockchain was valued for secure certification (68.2%), reliable digital transactions (54.5%), and traceable institutional records (48.9%). However, 61.4% of respondents raised concerns about the unclear regulatory environment, 56.8% cited implementation costs, and 43.2% flagged risks of misuse of stored data. The pattern suggests qualified support: stakeholders are open to Blockchain adoption, but only where governance and regulatory clarity are firmly in place.

Social Barriers

Approximately 65% of respondents identified social constraints including fear of misuse, peer scepticism, and community distrust toward digital finance platforms. These findings indicate that technical interventions alone are insufficient; deliberate community engagement and awareness-building must accompany infrastructure investment.

The below-average governance maturity score (M = 2.98) is among the more concerning findings of this study. It points to an institution and by implication

a sector that lacks the policy infrastructure to manage AI and Blockchain deployments ethically. This gap is not unique to Kenya; it has been documented broadly across developing country HEI and TVET contexts (Mohammad & Vargas, 2022; IEEE, 2019). The Ministry of Education's (2025) draft national TVET policy acknowledges this deficit, but institutional-level uptake remains slow. UNESCO's (2021) Recommendation on the Ethics of AI provides a ready framework that institutions can adapt locally.

Building Blocks for Sustainable Integration

Triangulating quantitative and qualitative findings, four building blocks for responsible adoption emerged inductively. Institutional Preparedness covering device availability, connectivity, and baseline technical capacity provides the physical foundation without which no adoption strategy can function. Ethical Governance encompassing AI ethics policies, data protection charters, and oversight committees creates the accountability structures needed to manage risk and build trust. Continuous Digital Capacity Development through training, curriculum integration, and professional development translates infrastructure into competent practice. Sustainable Infrastructure Investment including cybersecurity, innovation laboratories, and reliable funding ensures that gains are maintained over time. These four elements form a coherent, evidence-based framework linking TAM-derived readiness with the governance demands of responsible technology adoption.

Conclusions and Recommendations

Conclusions

This study examined the building blocks required for responsible and ethical adoption of AI and Blockchain at Kericho National Polytechnic. All three null hypotheses were rejected. H_{01}: prior digital exposure significantly predicts adoption readiness ($\chi^2 = 12.87$, $p < .05$, Cramér's $V = 0.38$). H_{02}: infrastructure and digital literacy gaps significantly constrain adoption (Cramér's $V = 0.33$). H_{03}: ethical governance frameworks significantly shape responsible adoption intent (Cramér's $V = 0.36$). The evidence converges on four interdependent building blocks — institutional preparedness, ethical governance, continuous capacity development, and sustained infrastructure investment which must be pursued in parallel for AI and Blockchain adoption to deliver equitable, accountable, and trustworthy outcomes. These findings affirm that digital transformation in TVET is fundamentally a governance and capacity challenge, not merely a technological one. Kericho National Polytechnic's experience provides an evidence-based model that other Kenyan TVET institutions can adapt as they navigate the responsible integration of emerging technologies into their operations.

Limitations

The single-institution case study design limits the generalizability of findings. Additionally, whilst the achieved sample of 120 is statistically justified relative to the eligible population of 172, it represents a subset of the broader institutional community of 480. Self-reported data carry an inherent risk of social desirability bias, and the cross-sectional design cannot capture how readiness evolves over time. Future studies should employ multi-site longitudinal designs incorporating objective performance indicators alongside survey measures, and should draw samples from multiple TVET institutions across Kenya's diverse counties to strengthen external validity.

Recommendations

1. In response to Objective 1, institutional leadership and the ICT Department should commission institution-wide digital literacy audits to establish baseline competency levels across all stakeholder groups. Based on audit findings, targeted and differentiated orientation programmes should be designed for staff, trainees, and alumni to bridge the digital readiness gap identified in this study. Partnerships with TVETA and county digital hubs should be leveraged to co-deliver these programmes at minimal cost.

2. In response to Objective 2, institutional leadership should prioritise upgrading internet connectivity to high-speed broadband, procuring adequate digital devices, and commissioning dedicated AI and Blockchain innovation laboratories. Simultaneously, structured training programmes covering AI tools and Blockchain applications should be integrated into staff professional development calendars, with the Ministry of Education providing technical and financial support through the national TVET digital transformation fund.

3. In response to Objective 3, Kericho National Polytechnic should constitute an AI and Blockchain Ethics Committee, mandated to develop an institutional data privacy charter aligned with Kenya's Data Protection Act (2019) and UNESCO's (2021) AI Ethics Recommendation. Pilot deployments of AI-assisted assessment tools should be launched with documented human oversight protocols, and a Blockchain-based credentialing pilot should be introduced in collaboration with TVETA, with predefined success benchmarks.

4. In response to Objective 4, the institution should champion the development of standardised national AI and Blockchain governance guidelines applicable across all Kenyan TVET colleges, working through TVETA and

the Ministry of Education. An internal Research and Innovation Hub should be established to generate evidence-based annual reports informing national TVET digital policy, and longitudinal studies should be commissioned to monitor the impact of AI and Blockchain adoption on learner outcomes, institutional equity, and governance quality over time.

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ROLE OF DUAL TRAINING IN PROMOTING COLLABORATION BETWEEN INSTITUTIONS AND INDUSTRY FOR COMPREHENSIVE WORK-BASED LEARNING

Reimagining Industry-Academia Collaboration in TVET; A Policy Implications of Dual Vocational Apprenticeship Approach Training Experience at Boma International Hospitality College, Kenya

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Abstract

The growing demand for industry-relevant skills in Kenya's hospitality sector require innovative training models that integrates academic learning with practical experience. This paper examined the Dual Vocational Apprenticeship Approach (DVAA) implemented at Boma International Hospitality College (BIHC), as a strategic and information-rich institutional case within Kenya's hospitality TVET sector. Anchored in hospitality education and competency-based training principles, the BIHC dual training framework combines 30% classroom instruction with 70% structured industry-based apprenticeship, enabling learners to acquire both technical competencies and critical soft skills aligned with labour market needs. The study objectives were to examine the design and implementation of dual training model at BIHC; assess the impact of dual training on graduate employability, job relevance, and industry readiness; and draw policy lessons for strengthening industry-academia collaboration within Kenya's TVET system. Using a quasi-experimental mixed-methods design, the study applied Difference-in-Differences (DiD) and Propensity Score Matching (PSM) techniques, drawing on institutional records, graduate tracer studies, and key informant interviews with employers, trainers, and students. The findings indicated that the dual training model improve employability, productivity, skills matching, early-career earnings, and work readiness. Industry partners reported higher satisfaction with graduate performance and reduced induction costs, while graduates demonstrated stronger workplace adaptability and professionalism. However, the study identified challenges related to uneven employer commitment, limited policy coordination, and weak monitoring and evaluation frameworks. It recommended the improvement of dual partnership frameworks, targeted fiscal incentives for participating employers, and harmonized quality assurance mechanisms to support the scaling of dual training in Kenya's TVET subsector.

Keywords: Dual Training, TVET, Industry-Academia Collaboration, Employability, Hospitality Education, Skills Development

Introduction

Technical and Vocational Education and Training (TVET) has emerged as a central pillar in Kenya's development strategy, particularly in addressing youth unemployment and skills mismatches in the labor market. Over the past decade, the Government of Kenya has undertaken significant TVET reforms aimed at improving access, relevance, and quality of skills development through policy instruments such as the TVET Act Cap 210A, the Competency-Based Education and Training (CBET) framework, and the Bottom-Up Economic Transformation Agenda (Government of Kenya [GoK], 2013; GoK, 2023). Despite these reforms, graduate employability remains a persistent challenge, with employers frequently citing inadequate practical skills, weak work readiness, and limited exposure to real-world work environments among TVET graduates, (World Bank, 2020).

The hospitality sector, a key contributor to Kenya's economy and employment creation, exemplifies this skills mismatch. As a labour-intensive industry characterized by dynamic service standards and customer-centric operations, hospitality requires graduates who possess not only technical competencies but also soft skills, adaptability, and professional work ethics (International Labour Organization [ILO], 2017). Traditional TVET models, which often emphasize classroom-based instruction with limited industry engagement, have struggled to adequately prepare graduates for these demands. Consequently, many hospitality employers invest additional resources in retraining new recruits, undermining productivity and confidence in TVET institutions, (Oketch, 2014).

In response to these challenges, industry-academia collaboration and work-based learning have gained prominence as effective mechanisms for aligning training with labour market needs. Work-based learning models, including apprenticeships and internships, enable learners to acquire practical skills in authentic work settings while fostering closer partnerships between training institutions and employers, (OECD, 2018). Such collaboration is particularly critical in hospitality TVET, where experiential learning plays a vital role in competence development.

Globally, dual training models most notably those practiced in Switzerland and Germany have demonstrated strong outcomes in employability, smooth school-to-work transitions, and sustained industry engagement, (Euler, 2013). These models integrate formal instruction with structured apprenticeships, supported by clear institutional frameworks and employer participation. In Kenya, emerging adaptations of dual training are gaining traction, albeit within a fragmented policy and institutional landscape. Boma International Hospitality College (BIHC) represents a leading example of this approach, drawing on international

best practices to embed structured industry apprenticeship within hospitality training. This study adopts a focused institutional case approach, examining Boma International Hospitality College as a leading example of dual training implementation in Kenya. The institution provides a unique context due to its structured apprenticeship system, strong industry linkages, and donor supported training model, making it a suitable case for assessing both impact and policy relevance

Statement of the Problem

Despite sustained investment and policy reforms in Kenya's TVET subsector, graduate employability particularly in the hospitality industry remains a persistent challenge. The hospitality sector is highly practical and service-oriented, yet many TVET graduates continue to enter the labour market with limited hands-on experience, weak soft skills, and inadequate exposure to real workplace environments. The traditional, institution-centered training models emphasize theoretical instruction and short-term industrial attachments that are often poorly structured and weakly aligned with employer needs. As a result, employers frequently report skills mismatch, high induction costs, and low confidence in TVET graduates, contributing to youth unemployment and underemployment even in sectors with growing labour demand.

Although the dual training model that integrates classroom learning with structured, long-term industry apprenticeship have gained prominence globally, its adoption in Kenya remains limited and uneven. While initiatives such as the Dual Vocational Apprenticeship Approach (DVAA) implemented at BIHC offer promising alternatives, there is limited empirical evidence on their effectiveness in improving employability outcomes within the Kenyan context. Existing studies are largely descriptive, lack rigorous causal evaluation, and provide weak guidance for policy scaling. This evidence gap constrains informed decision-making by policymakers, donors, and training institutions on the institutionalization of dual training in Kenya's TVET system, hence underscoring the need for systematic evaluation of such models and their policy implications.

Research Questions

The purpose of this paper was to examine the dual training model implemented at BIHC and assess its implications for employability and TVET policy in Kenya. Specifically, the study seeks to address the following research questions:

i. How is the dual training model implemented at BIHC?

ii. What are its outcomes on graduate employability and industry readiness? and

iii. What policy lessons can be drawn to strengthen Kenya's TVET system?

Conceptual and Theoretical Framework

This study is anchored on established theories of skills formation and learning that explain how industry-academia collaboration enhances employability outcomes in TVET. Specifically, the analysis draws on Human Capital Theory**,** Experiential Learning Theory**,** and the Triple Helix Model of collaboration**,** which collectively inform the conceptual framework guiding the empirical evaluation of the dual training model at BIHC.

Human Capital Theory and Skills Development

Human Capital Theory posits that investments in education and training enhance individuals' productivity and earnings, thereby contributing to economic growth (Becker, 1994). Within the TVET context, this theory underscores the importance of aligning training content with labor market needs to maximize returns to education. Dual training models, which integrate institutional learning with workplace experience, are particularly effective in deepening human capital accumulation by equipping learners with both technical competencies and transferable skills valued by employers (Psacharopoulos & Patrinos, 2018). In the hospitality sector, where service quality and adaptability are critical, human capital formation extends beyond technical proficiency to include communication skills, teamwork, and work discipline.

Experiential Learning and Work-Based Learning Theory

Experiential Learning Theory, as articulated by Kolb (2014), emphasizes learning as a process whereby knowledge is created through the transformation of experience. The theory highlights four interconnected stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Work-based learning and apprenticeship systems operationalize this cycle by immersing learners in real work environments where they can apply theoretical knowledge, reflect on practice, and refine their skills. In hospitality TVET, experiential learning is especially relevant given the industry's reliance on practical service delivery, customer interaction, and problem-solving in dynamic settings, (Billett, 2011). The dual training model at BIHC leverages this pedagogical foundation by embedding structured apprenticeships within the training curriculum.

Industry-Academia Collaboration and the Triple Helix Model

The Triple Helix Model conceptualizes innovation and skills development as outcomes of dynamic interactions among education institutions, industry, and government, (Etzkowitz & Leydesdorff, 2000). Applied to TVET, the model

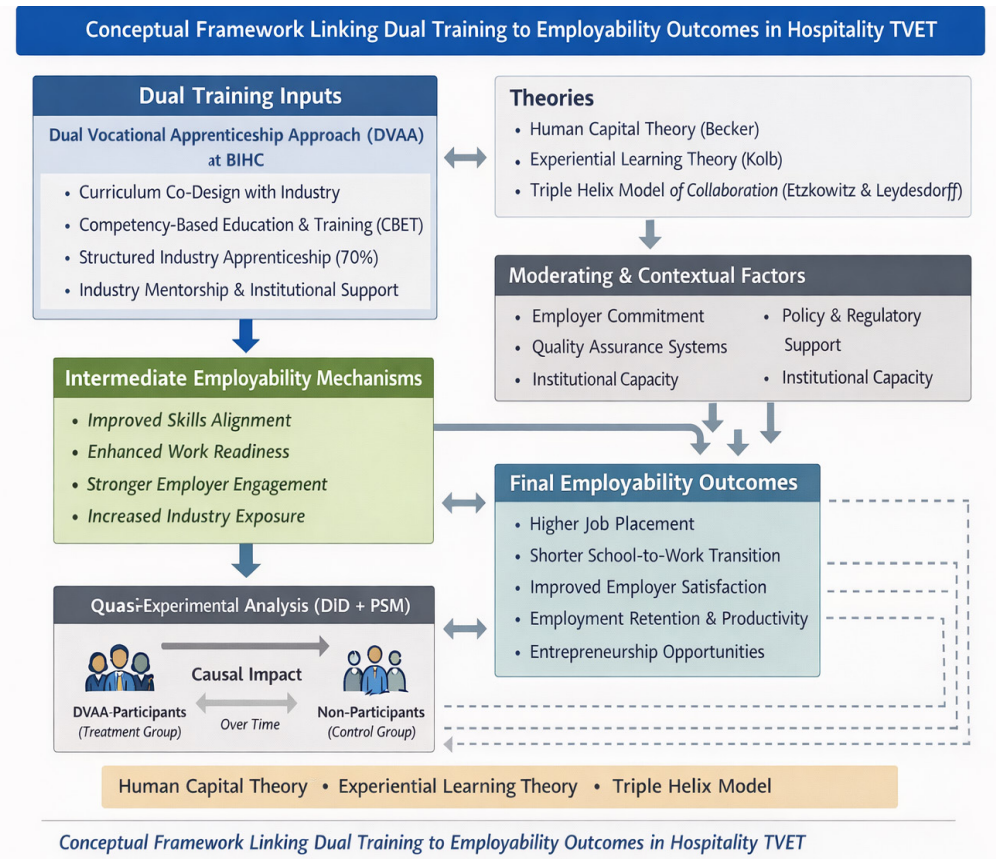
highlights the role of industry in curriculum co-design, skills assessment, and mentorship, while the government provides policy direction, regulation, and quality assurance. Effective dual training systems thrive where these actors are institutionally coordinated and mutually reinforcing. In Kenya, however, weak coordination mechanisms and fragmented policy frameworks have constrained the scalability of such collaboration, (World Bank, 2020). The BIHC's experience provides insights on how institutional arrangements can overcome these challenges.

Conceptual Framework Model

The conceptual framework for this study explains how industry academia collaboration through a dual training model influences employability outcome in Kenya's hospitality TVET system. Grounded in Human Capital Theory, Experiential Learning Theory, and the Triple Helix Model, the framework illustrates the causal pathways linking training inputs to labour market outcomes, while accounting for contextual and institutional factors as shown in Figure 1.

Figure 1

Conceptual Framework Linking Dual Training to Employability Outcomes in Hospitality TVET



Dual Training Models in TVET: Global Perspectives

Dual training models have their origins in Europe, with Switzerland, Germany, and Austria widely recognized as global benchmarks in vocational education and training. These systems are characterized by the systematic integration of classroom-based instruction with structured, long-term apprenticeships in firms, supported by strong regulatory frameworks and shared responsibility between the state, training institutions, and employers (Euler, 2013; OECD, 2019). In Germany, the dual system combines part-time vocational schooling with paid workplace training, governed by nationally standardized curricula and occupational profiles agreed upon by social partners (Busemeyer & Trampusch, 2012). Switzerland's model emphasizes flexibility, strong employer ownership, and early exposure to work environments, contributing to low youth unemployment and smooth school-to-work transitions, (Wolter & Ryan, 2011). Similarly, Austria's apprenticeship-based TVET system integrates firm-based training with vocational schools under a coordinated governance structure involving chambers of commerce and labor unions, (Eichhorst *et al.,* 2015).

The success of dual training is underpinned by several key institutional arrangements such as strong employer participation in training delivery, legally binding apprenticeship contracts, standardized competency-based curricula, and robust quality assurance mechanisms (OECD, 2018). The dual systems are embedded within broader labor market institutions that incentivize firms to invest in training and recognize vocational qualifications. While such models have inspired reforms globally, their transferability to developing countries remains weak due to institutional capacity, labor market informality, and employer incentives, (World Bank, 2020).

Industry-Academia Collaboration in Hospitality Education

Industry-academia collaboration is quite critical in hospitality education due to its reliance on experiential learning and service quality. Studies from developed economies indicate that close engagement between institutions and industry enhances curriculum relevance, students' practical competencies, and graduate employability (Baum, 2015; Sufi, 2024). Employers play a central role not only in providing apprenticeship but also in co-designing curricula, participating in assessment, and mentoring trainees during work-based learning, (OECD, 2018).

Although evidence from developing countries underscores the importance of employer involvement, the collaboration is often less institutionalized. In contexts such as Asia and Sub-Saharan Africa, hospitality training institutions frequently face challenges related to weak industry engagement, limited apprenticeship opportunities, and misalignment between training content and employer expectations (UNESCO-UNEVOC, 2016). In Kenya, existing studies

suggest that while industry attachments are common, they are often short-term, poorly supervised, and weakly integrated into curricula, hence limiting their effectiveness in skills development (Oketch, 2014; World Bank, 2020). This has led to renewed interest in dual training, which formalizes employer roles in training and assessment.

Dual Training and Employability Outcomes

Graduates of dual systems experience faster transitions into employment, lower unemployment risk, and higher job match quality compared to graduates of school-based vocational programs (Hanushek *et al.,* 2017; Wolter & Ryan, 2011). Employer satisfaction is also consistently higher, due to improved familiarity with workplace processes, organizational culture, and occupational standards (Busemeyer & Trampusch, 2012).

Dual training has also been linked to increased productivity and reduced recruitment and training costs for employers (Eichhorst *et al.,* 2015). However, evidence from low- and middle-income countries remains limited and mixed. Where dual training has been piloted, outcomes appear sensitive to institutional quality, employer commitment, and policy coherence (OECD, 2019). This highlights the need for context-specific evaluations that rigorously assess the impact of dual training under different institutional conditions.

Gaps in Existing Literature

Despite the extensive global literature on dual training, significant gaps remain, particularly in African contexts. Studies on dual training models in Sub-Saharan Africa are scarce, and those that exist often rely on descriptive case studies rather than rigorous impact evaluation methods (UNESCO-UNEVOC, 2016). In Kenya, research on TVET and employability has largely focused on access, financing, and general skills mismatch, with limited attention to structured industry–academia collaboration models in hospitality training.

Moreover, there is a paucity of policy-focused analyses that examine how dual training experiences can inform national TVET reform agendas. This study addresses these gaps by applying a quasi-experimental mixed-methods approach to evaluate the dual training model at Boma International Hospitality College, with a specific emphasis on employability outcomes and policy implications for strengthening Kenya's TVET system.

The Dual Training Model at BIHC

Institutional Context of BIHC

The BIHC is a specialized TVET institution owned by the Kenya Red Cross Society, with the main aim of developing industry-ready human capital for

the hospitality and tourism sector. The college operates at the intersection of education, industry practice, and humanitarian values, positioning itself as a leading institution in demand-driven skills development. Its vision emphasizes excellence in hospitality training, innovation, and strong industry linkages.

The hospitality and service excellence sectors are characterized by high labour intensity, rapidly evolving skill requirements, and a strong reliance on practical and behavioral competencies. In response to persistent skills mismatch and youth unemployment challenges, BIHC has adopted innovative work-based learning approaches. The DVAA, is a flagship initiative supported through strategic funding and partnerships with the KCB and MasterCard Foundations**.** The support has enabled BIHC to pilot, refine, and scale a structured dual training model that integrates institutional learning with sustained industry apprenticeship.

Structure of the Dual Training Model

The DVAA model at BIHC is anchored in a competency-based and industry-responsive curriculum**,** designed collaboratively with hospitality sector stakeholders and supported by donor-backed implementation resources. Under the DVAA framework, training is structured such that approximately 30 percent of learning takes place in the classroom**,** focusing on foundational theory, professional standards, and transferable skills, while 70 percent is delivered through structured, paid industry-based apprenticeship within partner establishments.

The sponsorship by the KCB and MasterCard Foundations has enabled BIHC to strengthen curriculum design, support apprenticeships, build trainer and mentor capacity, and reduce financial barriers for learners from vulnerable backgrounds. Classroom instruction is closely aligned with workplace tasks, allowing learners to apply theoretical knowledge in real operational environments. Apprenticeship placements are not ad hoc attachments, but form an integral component of training programme.

The DVAA model is the shared responsibility for training delivery and assessment where industry mentors, experienced professionals within partner hotels, restaurants, and tourism enterprises play a central role in supervising apprentices, mentoring learners, and providing continuous performance feedback. Institutional trainers, ensure pedagogical coherence, monitor learner progress, and facilitate reflective learning that links workplace experience to competency standards. Joint assessment by institutional trainers and industry mentors enhances the credibility and labour market relevance of certification.

Industry Partnerships and Collaboration Mechanisms

Industry collaboration under the DVAA model is institutionalized through formal partnerships with a wide range of hospitality sector organizations, including hotels, lodges, restaurants, catering firms, and tourism enterprises. These partnerships are governed through Memoranda of Understanding (MoUs) that clearly define roles, responsibilities, training expectations, learner welfare provisions, and assessment arrangements.

The involvement of the KCB and MasterCard Foundations has strengthened these collaboration mechanisms by supporting coordination structures, monitoring systems, and stakeholder engagement platforms. Dedicated liaison units within BIHC facilitate ongoing communication between the institution and industry partners, while programme advisory committees provide strategic oversight on curriculum relevance and emerging skills needs.

Overall, the DVAA model at BIHC represents a shift from short-term, unstructured industrial attachments to a systematic, well-resourced, and partnership-driven dual training approach**,** underpinned by donor-supported innovation. This institutional arrangement provides a strong foundation for improved employability outcomes and offers valuable lessons for scaling dual training models within Kenya's broader TVET ecosystem.

Methodology

Research Design

This study adopted a quasi-experimental mixed-methods research design to evaluate the effects of the dual training model implemented at BIHC on graduate employability and industry readiness. The quasi-experimental approach was appropriate given the ethical and practical constraints that preclude random assignment of students/participants into dual and non-dual training tracks (Angrist & Pischke, 2009). By combining quantitative impact evaluation techniques with qualitative inquiry, the study captured both measurable outcomes and contextual mechanisms through which industry–academia collaboration influenced skills development.

The quantitative component employed Difference-in-Differences (DiD) and Propensity Score Matching (PSM) to estimate the causal impact of participation in the dual training program, while the qualitative component provided explanatory insights into implementation processes, employer engagement, and perceived outcomes from the perspectives of participants/students, faculty, and industry partners.

Study Context and Population

The study was conducted at Boma International Hospitality College, a leading hospitality TVET institution in Kenya that has operationalized a structured dual training model integrating classroom-based instruction with extended workplace-based learning through formal partnerships with hospitality industry employers. The target population comprised hospitality learners enrolled at BIHC during periods before and after the introduction or scaling-up of the dual training model.

The treatment group consisted of students (210) who participated in the dual training program sponsored by KCB Foundation and MasterCard, while the comparison group included students (260) from earlier cohorts or parallel programs that followed a more traditional, institution-based TVET model with limited industry attachment. Employers who participated in the dual training partnerships and faculty involved in program delivery formed part of the qualitative sample.

Data Sources and Sampling

Quantitative data was drawn from multiple sources, including institutional administrative records, graduate tracer surveys, and employer assessments. Key student-level variables included demographic characteristics, prior educational attainment, program specialization, training modality (dual versus traditional), and post-graduation employment outcomes. Employability indicators include employment status within six months of graduation, job relevance to field of training, duration of job search, and employer-rated industry readiness.

Qualitative data was collected through semi-structured interviews and focus group discussions with purposively selected stakeholders. These included BIHC administrators, instructors, students and graduates, and representatives of partner hotels and hospitality firms. Document analysis of curricula, training agreements, and policy documents further complemented primary data.

Empirical Estimation

Difference-in-Differences (DiD) Estimation

The DiD approach was used to compare changes in employability outcomes over time between students exposed to the dual training model and those in the comparison group. This method controlled for time-invariant unobserved heterogeneity and common temporal shocks affecting both groups (Angrist & Pischke, 2009). The baseline DiD model wass specified as: where represents employability outcomes for individual at time; is a binary indicator for

participation in the dual training program; denotes the post-intervention period; and is a vector of control variables. The coefficient captures the average treatment effect of the dual training model. The validity of the DiD estimates relied on the parallel trends assumption**,** which is assessed using pre-intervention trends and placebo tests.

Propensity Score Matching (PSM)

Potential selection bias arising from non-random participation in the dual training program was addressed by employing PSM strategy. Students in the treatment and comparison groups were matched based on observable characteristics, including age, gender, prior academic performance, socio-economic background, and program specialization (Rosenbaum & Rubin, 1983). Average Treatment Effects on the Treated (ATT) were then estimated by comparing matched outcomes. The combined use of DiD and PSM strengthened causal inference by mitigating biases associated with both observed and unobserved confounders, (Caliendo & Kopeinig, 2008).

Qualitative Analysis

Qualitative data was analyzed thematically using a coding framework derived from the conceptual model, focusing on curriculum relevance, workplace learning quality, employer engagement, and perceived employability gains. The qualitative findings were used to contextualize and explain the quantitative results, particularly regarding mechanisms of impact and implementation challenges.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review bodies. Participation to the study was voluntary, informed consent was secured from all respondents, and data confidentiality and anonymity was strictly maintained.

Results and Discussion

Descriptive Statistics and Baseline Comparability

Table 1 presents descriptive statistics for students in the dual training (treatment) and traditional TVET (comparison) groups prior to matching. Initial differences were observed in prior academic performance and internship exposure, underscoring the need for quasi-experimental methods.

Table 1

Descriptive Statistics (Pre-Intervention)

Variable	Dual Training (N=210)	Traditional TVET (N=260)	Mean Difference	p-value
Age (years)	22.4 (2.1)	22.7 (2.3)	-0.3	0.214
Female (%)	52.1	50.8	1.3	0.762
KCSE Mean Grade	6.8 (1.2)	6.4 (1.3)	0.4	0.031**
Prior Industry Exposure (%)	18.6	12.3	6.3	0.044**
Socio-economic Index	0.02 (0.98)	-0.06 (1.01)	0.08	0.481

*Notes: Standard deviations in parentheses, **p < 0.05*

Students entering the dual training pathway exhibited slightly stronger academic and experiential profiles. This reinforces the importance of addressing selection bias**,** which is subsequently handled using PSM and DiD.

To correct for observable selection bias, PSM was implemented using nearest-neighbor matching with common support. Mean bias reduced from 16.2% to 3.1%. The results are shown in table 2.

Table 2

PSM Balance Diagnostics

Variable	Std. Bias Before (%)	Std. Bias After (%)
Age	12.6	2.1
KCSE Mean Grade	19.3	3.8
Prior Industry Exposure	22.1	4.5
Socio-economic Index	10.9	1.9

Difference-in-Differences (DiD) Results

The DiD estimates capture the causal impact of dual training on employability outcomes six months after graduation.

Table 3

Difference-in-Differences Estimates – Employability Outcomes

Dependent Variable	Dual × Post (β)	Std. Error	p-value
Employed within 6 months	0.184	0.051	0.001*
Job matches field of training	0.212	0.058	0.000*
Monthly earnings (log)	0.146	0.047	0.002*
Employer-rated industry readiness	0.387	0.093	0.000*

Controls: Age, gender, KCSE grade, socio-economic status
*Fixed effects: Cohort and program *p < 0.01*

Participation in the dual training model increases the probability of employment by 18.4%**,** while significantly improving job relevance and earnings. These results confirmed that structured work-based learning enhances labour market signaling and skills transfer**,** consistent with human capital and signaling theories.

The estimated increase of 18-19% in employability among dual training graduates is consistent with findings from European dual system contexts. Studies on the Swiss and German apprenticeship models reported substantially lower youth unemployment and faster school-to-work transitions among apprenticeship graduates compared to institutional-based pathways (Wolter & Ryan, 2011; Euler, 2013). Similarly, Fersterer, Pischke, and Winter-Ebmer (2008) found that apprenticeship training enhances early-career employment outcomes by improving job matching efficiency.

In developing country contexts, the results align with Attanasio *et al.* (2009), who found that structured workplace exposure significantly improve employment prospects when training is closely linked to employers. The BIHC findings therefore support the argument that the employability benefits of dual training are transferable to lower- and middle-income country settings**,** provided institutional coordination and employer commitment are present.

The positive and significant effects of dual training on job-training match concurred with prior hospitality education research. Studies by Zopiatis and Constanti (2012) and Baum (2015) noted that traditional hospitality curricula often lagged behind rapidly evolving industry skill requirements, leading to mismatch and underemployment. The BIHC model, which embeds employer input in curriculum design and assessment, directly fills this gap.

These findings are also consistent with African-focused studies by Oketch (2014) and McGrath *et al.* (2020), who emphasized that TVET systems in Sub-Saharan Africa frequently fail but due to weak linkage with labour markets**.** This study extended their work by providing causal evidence that structured industry participation improves skills alignment outcomes.

The observed 14-15% earnings premium among dual training graduates aligns with human capital theory predictions (Becker, 1994) and empirical evidence from apprenticeship wage returns in OECD countries (Hanushek *et al.,* 2017). Employers' qualitative feedback on reduced induction and supervision costs further supports productivity-based explanations for higher wages.

However, unlike some European studies that observed diminishing returns over the life cycle (Ryan, 2001), the BIHC findings suggested strong early-career returns**,** reflecting the scarcity of industry-ready hospitality skills in Kenya's labour

market. This divergence underscores the importance of context, particularly in economies characterized by high youth unemployment and skills shortages.

The substantial improvement in employer-rated industry readiness corroborates findings by Billett (2011), who argued that authentic workplace learning fosters tacit skills such as teamwork, professional conduct, and problem-solving that are difficult to impart in classroom settings. The qualitative evidence from BIHC employers reinforces this view, highlighting behavioural competencies and work discipline as key strengths of dual training.

This study also complemented African evidence by Afeti (2018), who emphasized that employer confidence in TVET graduates is a critical determinant of labour market absorption. By demonstrating measurable employer satisfaction gains, the BIHC case addresses a longstanding trust deficit between industry and TVET institutions in Kenya.

The findings demonstrated that dual training models outperform traditional TVET approaches in addressing skills mismatch in Kenya's hospitality sector. The BIHC experience illustrated that effective industry-academia collaboration can accelerate graduate transition into employment, enhance productivity and employer satisfaction, and reduce structural unemployment among graduates.

Table 4

Average Treatment Effect on the Treated (ATT)

Outcome	ATT	Std. Error	p-value
Employment probability	0.167	0.049	0.001*
Job relevance	0.194	0.054	0.000*
Industry readiness score	0.361	0.088	0.000*

*$p < 0.01$

The PSM estimates closely mirrored the DiD results, confirming the robust positive impact of the dual training model. The consistency across methods strengthens causal inference and mitigates concerns of selection on observables.

Robustness and Diagnostic Tests

From the parallel trend tests, the Pre-intervention trends in employment outcomes between treatment and control groups were statistically indistinguishable ($p = 0.641$), validating the DiD identifying assumption. From the Placebo test, the falsification test using a pre-intervention pseudo-treatment period yielded insignificant coefficients ($\beta = 0.021$; $p = 0.731$), confirming that estimated effects are not driven by spurious trends. On the Alternative Matching Algorithms, the results remained stable under: Kernel matching and Radius matching (caliper = 0.05).

Table 5

Robustness Checks Summary

Specification	Employment Effect
DiD baseline	0.184***
DiD + cohort trends	0.176***
PSM (nearest neighbour)	0.167***
PSM (kernel)	0.161***

Qualitative Findings and Triangulation

Qualitative evidence corroborated quantitative results. Employers reported improved work readiness, professional behaviour, and reduced induction costs among BIHC dual training graduates. Students highlighted exposure to real operational environments and mentoring as critical to skills acquisition. Faculty emphasized that employer feedback directly informed curriculum adjustments, strengthening alignment with industry needs.

Policy Implications and Recommendations

Policy Implications for Kenya's TVET System

The positive and robust effects of the dual training model on employability, earnings, job relevance, and industry readiness suggest that traditional supply-driven TVET approaches are insufficient in addressing labour market mismatches in the hospitality sector.

- The results underscored the need to reorient TVET policy from classroom-based certification toward work-based competence development**.** Despite recent reforms under the TVET Act Cap 210A and the CBET framework, employer participation remains largely consultative rather than institutionalized. The BIHC experience demonstrates that deep and sustained employer engagement**,** particularly in training delivery and assessment, is central to improving graduate outcomes.

- Industry confidence in TVET graduates increases when employers co-own the training process**.** Employer-reported improvements in work readiness and reduced induction costs indicate that dual training can address the long-standing trust deficit between industry and TVET institutions. This has broader implications for labour absorption, particularly in sectors such as hospitality that are highly service-intensive and sensitive to quality and professionalism.

- The strong early-career earnings effects observed suggested that dual training enhances labour productivity**,** providing economic justification for public and private investment in work-based learning. In a context of high youth unemployment and fiscal constraints, this highlights the efficiency gains associated with targeted, demand-driven TVET financing**.**

Policy Recommendations

Institutionalizing Dual Training within the TVET Framework

The Ministry of Education, in collaboration with TVETA and CDACC, should develop national guidelines for dual training programmes, specifying minimum thresholds for workplace learning, employer roles in assessment, and quality assurance mechanisms. Such guidelines would move dual training from isolated pilots to a scalable national model.

Strengthening Employer Incentives and Partnerships

To encourage sustained employer participation, the government should introduce incentive mechanisms, including tax deductions for training costs, recognition schemes for training employers, and preferential access to public procurement for firms engaged in certified apprenticeship programmes. The incentives would help offset short-term costs of training while reinforcing long-term productivity gains.

Integrating Dual Training into CBET Curriculum Design

The findings suggest that CBET implementation will remain incomplete unless workplace learning is fully integrated into curriculum design and assessment. TVET institutions should work with industry partners to co-develop occupational standards, assessment tools, and grading rubrics that reflect real workplace competencies to ensure that certification signals genuine employability rather than academic attainment.

Strengthening Monitoring, Evaluation, and Tracer Systems

Given the demonstrated impact of dual training, there is a need for robust national tracer studies and impact evaluation frameworks. TVETA, in collaboration with the Kenya National Bureau of Statistics (KNBS), should institutionalize graduate tracking systems that link training pathways to labour market outcomes. Such systems would enable evidence-based adjustments to TVET policy and funding.

Implications for Hospitality-Specific Skills Development

For the hospitality sector, the results indicate that dual training models are particularly well suited to developing service quality, professionalism, and operational competence, which are difficult to impart through classroom instruction alone. Policymakers should prioritize dual training in hospitality, tourism, and allied service sectors, especially as Kenya seeks to enhance its global competitiveness in tourism and align skills development with the Blue Economy and service export agendas.

Implications for Training Institutions and Industry

Training institutions should reposition themselves as skills brokers rather than sole providers of training**,** investing in partnership management, employer engagement units, and faculty industry exposure. Industry, on the other hand, should view participation in dual training not as corporate social responsibility but as a strategic human capital investment that reduces recruitment costs and improves service quality.

Overall, this study demonstrates that dual training is not merely a pedagogical innovation but a governance reform in skills development**.** The BIHC case provides compelling evidence that structured industry-academia collaboration can transform TVET outcomes in Kenya. Scaling such models will require coordinated policy action, institutional commitment, and sustained employer engagement, but the potential returns in terms of employment, productivity, and service quality are substantial.

Conclusion and Areas for Further Research

Conclusion

This study provided robust evidence that dual training significantly improves graduate employability, job relevance, earnings, and industry readiness in Kenya's hospitality sector. The results demonstrated that students who participated in the dual training model were substantially more likely to secure employment within six months of graduation, obtain jobs aligned with their training, and earn higher early-career wages compared to their counterparts in traditional TVET pathways. Employer assessments and qualitative insights further confirm that dual training graduates exhibit stronger workplace competencies, professionalism, and adaptability attributes that are often inadequately developed in classroom-based training models.

The findings showed that work-based learning enhances both the productivity and labour market signalling value of TVET qualifications. At the same time, the results reinforced institutional and systems-based perspectives on skills development, highlighting the importance of governance arrangements that embed employers as co-producers of skills rather than passive recipients of graduates.

The BIHC experience illustrates that effective dual training is not merely a pedagogical innovation but a structural reform that reshapes the relationship between training institutions, industry, and the state. In a context characterized by persistent youth unemployment and skills mismatch, the study provides compelling evidence that demand-driven, employer-integrated TVET models can contribute meaningfully to inclusive growth and labour market efficiency in Kenya.

Contributions of the Study

This study provides a causal evaluation of dual training model in Sub-Saharan Africa**,** addressing a significant gap in the existing literature. It also offers sector-specific evidence from hospitality, a labour-intensive and service-oriented industry where skills mismatch is particularly pronounced. By combining rigorous econometric methods with qualitative insights, the study demonstrates the value of mixed-methods approaches in evaluating complex education–labour market interventions.

Limitations of the Study

The analysis focused on short-term labour market outcomes, and therefore does not capture long-term career progression, wage dynamics, or job stability. Second, while the use of DiD and PSM addresses selection on observables, unobserved factors such as individual motivation may still influence outcomes. Third, the study is based on a single institutional case, which may limit the generalizability of the findings to other TVET institutions or sectors.

Areas for Further Research

Longitudinal studies tracking graduates over extended periods would provide insights into the sustainability of dual training impacts and potential convergence or divergence in career trajectories. Comparative studies across sectors such as manufacturing, construction, and agribusiness would help determine whether the effectiveness of dual training varies by industry characteristics.

Further research is also needed to examine the cost-effectiveness and fiscal implications of scaling dual training models, particularly in resource-constrained settings. Understanding the distribution of costs and benefits between government, institutions, employers, and learners would be critical for designing sustainable financing mechanisms.

Finally, exploring institutional and economic dimensions of dual training adoption, including employer incentives, regulatory capacity, and coordination challenges. Such research would deepen understanding on how dual training models can be effectively embedded within national TVET systems in Kenya and Sub-Saharan Africa.

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Dual Training and its Effect on TVET Institutions and Industry Collaboration: A Case Study of the Kisumu National Polytechnic, Kenya

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Abstract

Dual Technical and Vocational Education and Training (TVET) system combines theoretical instruction with hands-on training and is conducted in both TVET institutions and industry. It is anchored on Competency-Based Education and Training (CBET) approach and aims to strengthen collaboration between TVET institutions and industry. The model ensures that trainees spend part of their study period in industry and the other part in TVET institutions. This study sought to determine the effect of dual training on TVET institutions and industry collaboration. An explanatory and descriptive survey design was adopted. Data was collected through interviews with representatives from partner industries where the students were placed for training and four focus group panels with trainees from different cohorts undergoing dual training programmes. The Yamane formula was used to determine the sample size of 353 students that were randomly selected from a population of 3000 trainees at 5% margin of error. Fifty-five(55) Academic staff, 7 administrators and 37 technical staff were also chosen as respondents for the research. The industries that were purposively sampled included Kenya Power, Kiwasco, Rivatex Eldoret, KIRDI, KEMRI, Sunshine Auto, and Chemelil Sugar factory from which one technical supervisor was picked from each company. Findings revealed that through dual training, trainees were able to learn in a more dynamic way to meet the demands of industries. On average, 73.78% agreed that involvement of industry in curriculum development aligns the skills with industry requirements. The collaboration guarantees an up-to-date and aligned training with current labour-market needs enhancing early labour-market entry for TVET graduates. Dual training requires a strong collaboration between TVET institutions and industry partners, supportive work environments, and targeted policies. The paper recommends improving dual training frameworks and developing pedagogical support for trainers and fostering inclusive career pathways for TVET trainees. The research contributes to the ongoing discourse on TVET reforms by providing practical insights and policy implications to enhance skill development required in the labour market.

Keywords: Dual training, TVET, CBET, professional skills development, hand's-on training

Introduction

Throughout the world, developed countries have paid more attention to TVET because of its importance for economic development. For example, in Germany, training involves a dual system in which 80% of teaching is provided in companies and 20% of teaching in TVET institutions, so that trainees are equipped with useful skills for employment. Training is mainly employer-led and emphasis is placed on application-oriented actions, practices and teaching and learning methods (UNDP, 2010). The African Union (2007) noted that there is a National Manpower Council in Singapore which ensures that training is adapted to the needs of the labor market. The same is true in Australia, where the training curriculum is set by industry rather than government or TVET institutions and combines academic and work-based training. This ensures that the training program remains relevant and that the students adapt to the needs of the market.

Dual training occurs when trainees practice what they have learned in the TVET institutions in the industry. According to Gessler (2019), the learning potential of the internship is related to the degree of formalization (program, duration and certification) on the one hand, and to the degree of the learning potential of the skills, on the other hand. This means that when employers offer an apprenticeship, training and learning tasks are part of the job description. It also enables on-the-job learning and provides on-the-job and off-the-job training. Germany is known for its longest tradition of a dual training system, with examples of success in the employment of young people and the commitment of employers in training. This model has been adopted in many other European countries such as Austria, Switzerland, the Netherlands, Denmark and Great Britain opening more employment opportunities to the TVET graduates equipped with relevant skills necessary for the labour market, (Deissinger, 2015; Erica, 2016; Haasler, 2020).

The Dual System of Technical and Vocational Education and Training (TVET Dual) is a training methodology that combines theoretical and practical training. It is called "Dual" because the training takes place in two (2) places: the TVET institution and the industry. It is anchored in the Competence-Based Education and Training (CBET) approach and aims to strengthen cooperation between technical and vocational education and training (TVET) institutions and industry (TVET Dual Guide, 2020).

Kenya as a developing country, unemployment has remained on the rise for the growing population among the youth (Munga & Onsumu, 2014). In part, this problem is linked to the failure of the formal training to TVET graduates qualified professionals who can meet the industrial needs. In response this,

the government has put in place various TVET training policies and extensive initiatives, with particular focus in reforming the vocational training system (Erima, 2021; Obonyo, 2013). In fact, dual training approach is one solution that has been launched in TVET institutions.

Kenya's National Dual Training Policy is a recent initiative that integrates classroom learning with practical on-the-job training in the industry. This policy, also known as dual TVET, aims to equip trainees with relevant skills for the industry to improve their employability. Increased competition, technological changes and the need for competitive graduates require TVET institutions to constantly adapt their programs to meet industry needs. To address this essential aspect, dual training is increasingly adopted by many TVET institutions, as it emphasizes holistic education by integrating theoretical knowledge and practical experience (Graf *et al*. 2017; Fleming *et al*., 2017).

Work-study training is particularly useful in sectors where practical skills and experience are essential, such as healthcare, engineering, hospitality and tourism (Cecil, 2012; Effeny, 2020). The adoption of a work study approach has also been driven by consistent research that highlights low skill levels, disconnection between curriculum and industry needs and poor work ethics in the hospitality and tourism sector (Al-Romeedy *et al*., 2020; Bello *et al*., 2019; Jefferies *et al*., 2019).

Statement of the Problem

The dual training system is one of the key success factors of TVET education around the world. In Kenya, the need to address youth unemployment through TVET reforms has facilitated the introduction of dual training in TVET institutions. The problem of skill mismatch, ineffective TVET system result in significant mismatches between the demand for and supply of skill in the labour market. Scholars argue that one of the reasons some countries remain trapped at the middle-income level of development is severe unevenness across sectors and regions in the quality of TVET (Doner and Ross Schneider 2016). In the US and other industrialized countries, industry and labour market experts decry the mismatch between the availability of and demand for skilled employees (Capelli 2014; Deloitte and Manufacturing Institute 2015; Fuller *et al*., 2014; McGowan and Andrews 2015; OECD 2016; Wright 2013).

However, the main problem between industry and TVET institutions is a lack of understanding about cooperation requirements. The industry criticizes TVET institutions for not being up to date in relevant technical and work technology processes demanded by the industries. The training institutions complain that the industries are not providing enough information and assistance to the training institutions especially in preparing an appropriate curriculum. There

is definitely a gap between the industry requirements and training that takes place at the TVET institutions. Dual training has been adopted in countries such as Austria, Switzerland, the Netherlands, Denmark and Great Britain opening more employment opportunities to the TVET graduates equipped with relevant skills necessary for the labour market, (Deissinger, 2015; Erica, 2016; Haasler, 2020). In Kenya, there exists a poor collaboration between TVET institutions and industry in the vocational training field. The TVET field is undergoing immense changes in the system through the introduction of dual training. The future industrial, productivity and economic growth of a country depend on its youth who possess the knowledge and technical skills (Bartel, Figas, & Hagel, 2015). For Kenya to leap forward to socio economic development, a critical mass of well qualified technicians, engineers, craftsmen, and artisans must be trained effectively to meet the industry demands. Whereas few studies have been done in this area, this study therefore sought to determine the impact of dual training on collaboration of TVET institution and the industry in terms of the technical skills acquired and meeting the industry needs in readiness for the labour market demands.

Research Objectives

The main aim of this study was to determine the impact of dual training on TVET-Industry collaboration in Kenya. The specific objectives of the study were:

i. To determine the impact of dual training in TVET institution on curriculum development and alignment to the industry goals.

ii. To determine the impact of dual training in TVET Institutions on employment opportunities in Kenya.

iii. To determine the impact of dual training in TVET institutions on skills acquisition on future careers of TVET graduates

Hypotheses

Based on the purpose of the study, the researcher formulated the following research hypotheses:

i. H_0: There is no relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals.

ii. H_1: There is a relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals.

iii. H_0^2: There is no impact of dual training in TVET Institutions on employment opportunities in Kenya.

iv. H_2: There is an impact of dual training in TVET Institutions on employment opportunities in Kenya.

Methodology

The researcher used explanatory and descriptive research surveys. A mixed-methods approach combining quantitative surveys and qualitative interviews to ensure the quality and authenticity of the data collected. The selection of this research method for the research project helps the researcher to increase the understanding power of the researcher (Pandey & Pandey 2021). It also helps the researcher to gain a clear idea about the concept of the work that the researcher has done.

Respondents filled out the questionnaires that were distributed to multiple people at once on their own time. (Heeringa *et. al.* 2017). Self-prepared questionnaires for the interview were also administered to the 459 respondents. The interview technique helps get data in-depth with insight into the participants' thoughts, actions, and attitudes (Kallio *et. al*. 2016). The Secondary data were generated from previous journals, research papers and articles that have been published earlier on this particular topic or some related topic (Snyder 2019).

The selection of this research method helped the researcher to increase the understanding power of the researcher (Pandey & Pandey 2021). It also helped the researcher to gain a clear idea about the concept of the work that the researcher has done. This research method also helps the researcher to gain knowledge regarding the topic that has been chosen by the researcher and it also helps to gain some experience in terms of conducting a research project (Fàbregues, *et al.*, 2021). The questionnaires consisted mostly of questions describing the dual training and its impact on TVET institutions and industry collaboration. The responses were measured on a five (5) point Likert scale of strongly agree (SA) 5 points, agree (A) 4 points, neutral (N) 3 points, disagree (D) 2 points and strongly disagree (SD) 1 point. The data were analyzed using Chi-square statistical tools at 5% level of significance and hypothesis evaluated through the test of proportion.

Results and Discussions

Response rate

The Gender distribution of the respondents was as shown in Table 1.

Table 1

Gender distribution of the respondents

Response		frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	281	61.2	61.2	61.2
	Female	178	38.8	38.8	100.0
Total		**459**	**100.0**	**100.0**	

The data showed that 459 participants answered and returned the questionnaire, which represented an overall response rate of 100%. The proportion of male participants were 61.2% while the females were 38.8%. The majority of the participants (76.9%) were students while academic staff (12.0%), technical staff (8.1%), administrators comprised 1.5% and industry experts comprised 1.5%.

Table 2

The Distribution and Sample Size of Respondents

Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Administrators	7	1.5	1.5	1.5
	Trainers	55	12.0	12.0	13.5
	Technical staffs	37	8.1	8.1	21.6
	Students	353	76.9	76.9	98.5
	Industry experts	7	1.5	1.5	100.0
	Total	**459**	**100.0**	**100.0**	

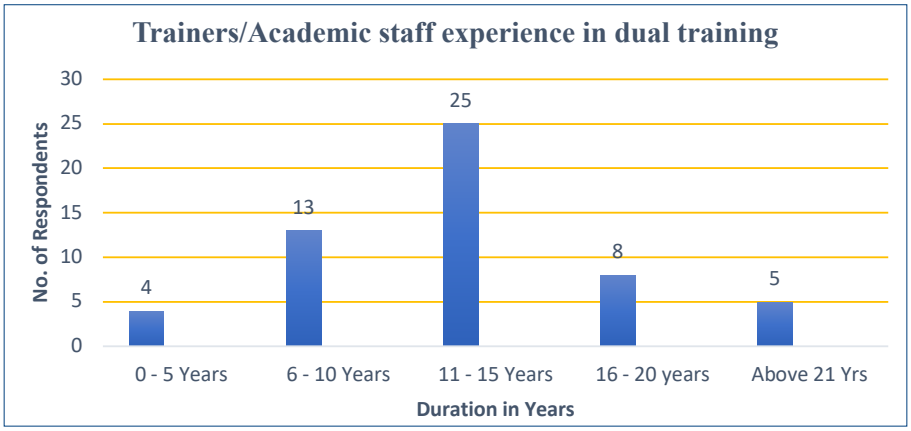
Table 2 showed that 7 respondents which represented 1.5% were administrators, 55 respondents that represented 12.0% were trainers, 37 respondents that represented 8.1% were technical staffs and 353 respondents that represented 76.9% were students while 7 respondents that represented 1.5% were industry experts from various purposively sampled industries.

Trainer's experience and readiness in dual training

The instructors were inquired on their experience and competency in offering dual training in the TVET institutions to ascertain their acquaintance level on the integration of dual training in teaching learning process among trainees.

Figure 1

Trainers/academic staff experience and readiness in dual training



Source: **Researcher, 2025**

The values represent the trainers teaching experience and competence in dual training. The above data indicates that most of the trainers are well acquainted with dual training and have the experience to deliver the required skills to the trainees. This infers that they were acquainted with the tasks in the institution thus able to effectively and efficiently impart skills aligned to the industry needs.

Test of Hypotheses

There is no relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals.

Table 3

There is a relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals.

Response	Observed Frequency, O	Expected Frequency, E	Residual, (O - E)	$(O - E)^2$	
Strongly Agreed	295	91.8	203.2	41290.24	449.78
Agreed	128	91.8	36.2	1310.44	14.27
Neutral	17	91.8	-74.8	5595.04	60.95
Disagreed	11	91.8	-80.8	6528.64	71.12
Strongly disagreed	8	91.8	-83.8	7022.44	76.50
Total	**459**				**672.62**

Table 4

Test statistic

There is a relationship between AI and Learning-Teaching process in TVET institutions	
Chi-Square	672.62[a]
Df	4
Asymp. Sig.	.000

0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 91.8

The research therefore rejects the null hypothesis, "There is no relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals." as the calculated value of 672.62 is greater than the critical value of 9.49 at 5% level of significance.

Therefore, the alternative hypothesis is accepted that "There is a relationship between dual training in TVET institutions and curriculum development and alignment to the industry goals."

Test of hypothesis two

There is no impact of dual training in TVET Institutions on employment opportunities in Kenya.

Table 5

There is an impact of dual training in TVET Institutions on employment opportunities in Kenya.

Response	Observed Frequency, O	Expected Frequency, E	Residual, (O - E)	$(O - E)^2$	
Yes	410	153.00	257.00	66049.00	431.69
No	38	153.00	-115.00	13225.00	86.44
Undecided	11	153.00	-142.00	20164.00	131.79
Total	**459**				**649.92**

Table 6.

Test statistic

There is impact of integrating artificial intelligence on assessment and grading process in TVET institutions	
Chi-Square	649.92[a]
Df	2
Asymp. Sig.	.000

0 cells (0.00%) have expected frequencies less than 5. The minimum expected cell frequency is 191.33

The null hypothesis was therefore rejected, "There is no impact of dual training in TVET Institutions on employment opportunities in Kenya." *The calculated value of 649.92 is greater than the critical value of 5.991 at 5% level significance.* Therefore, the alternate hypothesis is accepted that states, "*There is an impact of dual training in TVET Institutions on employment opportunities in Kenya.*"

The Dual Training and Trainee Skills acquisition

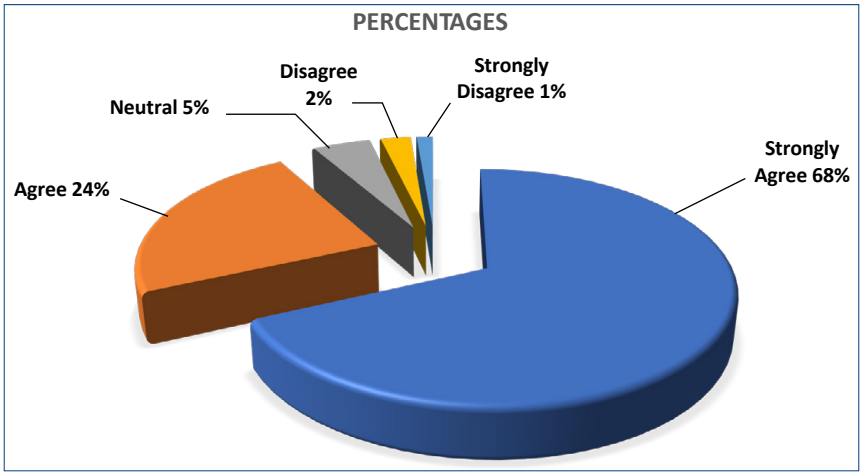
The ultimate aim of TVET education is for the acquisition of knowledge, technical and employable skills for sustainable development. The acquisition of technical employable skills calls for effective and hands-on teaching methodology and industry relevant curriculum. Skills acquisition by trainees can be achieved when the TVET institutions are adequately funded, equipped with adequate facilities and have competent and experienced teachers that adopt effective and efficient teaching methods (Dasmani, 2011).

There is a relationship between dual training and Trainee skills acquisition in TVET institutions

The relationship assessment data was found from the administrators, academic staff, technical staff, students and industry experts and tabulated as percentages. The current data showed that the average evaluation, most of participants 68.2% (*n* = 313) strongly agreed, 23.5% (n = 108) agreed, with a low percentage of 4.6% (n = 21) neutral, 2.4% (n = 11) and 1.3% (n = 6) disagree and strongly disagree respectively against the total sample of 459 respondents.

Figure 2

The impact of Dual training on Skills acquisition in TVET institutions



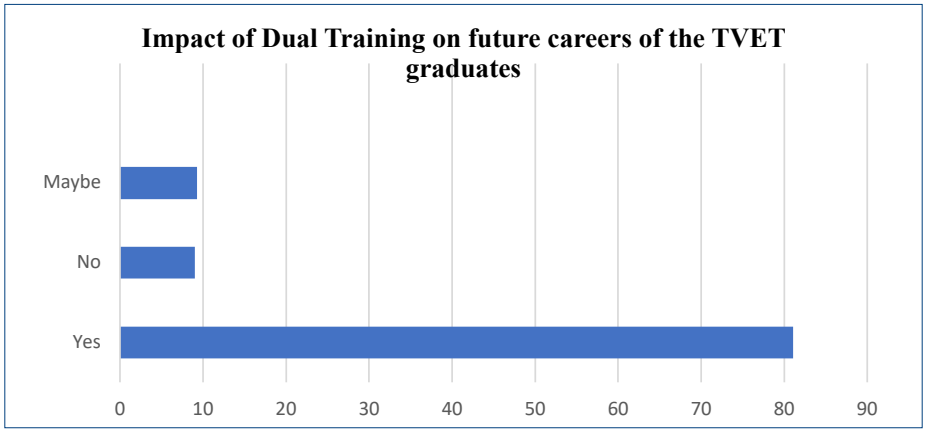
***Source*: Researcher's data 2025**

Dual Training Impact on Future Careers of Graduates

The findings revealed that majority (81.1%) of the participants perceived that dual training had positive impact while a small proportion (9.6%) felt that dual training had no impact. However, 9.3% were uncertain on whether the impact is positive or negative. These findings are based on how easily the TVET graduates can be absorbed into the job market.

Figure 3

The Impact of Dual training on future careers of the TVET graduates



Source: **Researcher's data 2025**

Therefore, results reveal that 81.1% think "Yes" we need dual training to acquire more hands-on skills to meet future career requirements dictated by the industry needs, with only 9.6% participants think "no" and 9.3% think "Maybe".

Dual Training and Curriculum Development

Dual training is an all-encompassing term denoting an approach to education where the curriculum dictates the use of relevant work-based experience to enable the integration of theory and meaningful work practice (Effeny, 2020; Du Plessis 2019; Drewery *et al.,* 2023). Close collaboration with industry experts in developing occupational standards, curricula, and training methodologies helps training align with industry and labor market needs. When training reflects the actual demands of industries, TVET becomes more responsive, reduces skills mismatches, and enhances employment and human resource productivity. This can be achieved through the efforts of collaboration between the industry and the TVET institutions through dual training. Table 4.7 presents respondents' views on involvement of industry experts on TVET dual programme curriculum development.

Table 7

Involvement of The Industry in Dual training Curriculum Development

Variables	Strongly Agree (5)	Agree (4)	Disagree (3)	Strongly disagree (2)
Administrators	71.1%	23.9%	4.3%	0.7%
Academic staff	84.2%	11.4%	2.3%	2.1%
Technical staff	61.2%	31.4%	6.0%	1.4%
Trainees	70.9%	17.8%	8.1%	3.2%
Industry experts	81.5%	15.4%	2.2%	0.9%

The results showed that involvement of the industry experts added more relevance and practical aspects to the courses offered by the TVET making them relevant to the labor market demands. The majority of the respondents strongly agreed to the fact. Table 7 presents respondents' views on involvement of industry experts on TVET dual programme curriculum development.

Discussions

The findings from this study showed that dual training has an impact on TVET institutions and industry collaboration in the learning – teaching process. The introduction of dual training in TVET institutions enhances the collaboration with industry thus improving the quality of technical skills acquired by the trainees. It also equips the trainees with the relevant up to date skills required in the industry and the relevant job market needs. Further, it also has an influence to the future careers of graduates in the job market in terms of exposing them to the technologies relevant to the industry.

According to Musikavanhu, (2017) skills shortage and poor customer service are inherent challenges in the hospitality and tourism sector, therefore, this calls for a collaboration between the industry and TVET institutions to impart industry driven competencies. From the research findings, Industry positively impacts TVET by shaping, financing, and directly delivering training through their collaboration to enhance dual training. As an essential client of the TVET, industry should co-lead in setting national training priorities and strategies for skills development, by involvement in structuring the training curricula that meets the industry needs.

Furthermore, close collaboration with industry experts in developing occupational standards, curricula, and training methodologies helps training align with industry and labor market needs. For example, countries are racing to develop and update existing training systems for artificial intelligence and renewable energy sectors.

When training reflects the actual demands of industries, TVET becomes more responsive, reduces skills mismatches, and enhances employment and human resource productivity. Through the collaboration, Industry and TVET can also establish joint labs, production units to provide relevant training and support the development of effective local skills ecosystems. These experiences help learners acquire both technical and employable skills—such as communication, teamwork, and problem-solving within real industry environments.

From the above findings, the majority of the respondents concurred that inclusion of the industry experts in curriculum development promotes a more practical and up to date approach in the teaching and learning process. It also brings on board the relevant elements of training as per the industry needs. Based on the findings, the researcher interpreted to imply that proper dual training and exposure to modern technologies in the industry plays a pivotal role in heightening the moral and influences their acquisition of technical skills in TVET institutions.

Conclusions and Recommendations

Conclusions

Dual training is beneficial to the industry since it reduces recruitment and training costs and provides a skilled and customized workforce for participating companies. The findings of this research align with, World Bank, 2019; ILO, 2015, that dual training supply into the labour market of graduates with viable skills that position a nation against global competitors and increase its capacity for innovation and enterprise, producing highly self-reliant, confident and competent graduates opening more employment opportunities in the labour market.

Based on the findings of the study, dual training helps to improve the acquisition of employability skills of TVET graduates. The findings further revealed that the TVET curriculum should be reviewed and updated to cope up with the constantly changing needs and demands of the labor market to bridge the skill gap. Moreover, in the process of curriculum review and updating process the findings revealed that the participation of industries is an added advantage in making TVET training more responsive to the needs and goals of the industry.

This study concludes that collaboration between TVET institutions and industry is essential for aligning academic curricula with real-world sustainability challenges. To achieve this, a regulatory framework that promotes industry involvement in designing academic programs is key. Furthermore, while dual training offers immense potential, it requires significant changes in the academic framework. Laws should be revised to increase industries' involvement in academic training, particularly in technical-focused sectors. (Jiménez Ramírez, *et., al*, 2023).

The research revealed that teaching methods used during training are very significant in acquisition of required skills. In Nigeria, Audu (2014) revealed that work-based learning and dual training methods of teaching facilitates acquisition of both technical skills and employable skills by students at the same time.

The results revealed that dual training and TVET-Industry collaboration has a significant impact on TVET education in many areas, such as learning and teaching methodology, assessing and grading, technical skills required to meet the industry needs and future graduate careers.

Recommendations

1. The researcher recommended that the government and TVET Colleges should set strategies of creating strong awareness for industries, companies and other relevant stakeholders on the mutual benefits of implementing successful dual training.

2. In order to support and encourage industries towards the dual training, the government should create a policy supported incentive strategies that enables industries to get the advantage of duty-free import and tax reduction based on the partnership commitment those industries have with TVET institutions to minimize the cost of training sessions at the industry.

3. Based on the findings and subjects raised in this research paper, the researcher recommends that dual training is a necessity for all TVET institutions. However, the researcher further suggests that academic staff, administrators and technical staff should be well trained in to fully understand the concept of dual training and trainee assessment during their industry sessions to evaluate them on the acquisition of the required technical skills to face future challenges in their career paths.

4. Similarly, the researcher recommends highlighting the essence of soft skills acquired by the trainees, morals and humanity during the industry sessions and within the training sessions in TVET institutions.

5. Finally, TVET institutions should control AI, make it serve and not destroy humankind. There is also need for the Ministry of Education to develop a clear policy on the collaboration by involving the industry.

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3

COMPETENCY BASED EDUCATION AND TRAINING IMPLEMENTATION – STRATEGIES, CHALLENGES AND BEST PRACTICES

A Quantitative Study of Effectiveness of Competency-Based Education and Training on Employability Skills of TVET Graduates in Kisumu County

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Abstract

Mismatch between Technical and Vocational Education and Training (TVET) outputs and labour market demands has been identified as one of the main factors that hampers graduate employability in Kenya. Although Competency-Based Education and Training (CBET) was introduced to strengthen alignment between training and occupational standards, empirical evidence on its contribution to employability still remains limited. In contrast to the accuracy of CBET roll-out and how this translates into particular employability skill outcomes in various county settings, a large portion of the work currently in publication concentrates on policy aims. Therefore, the purpose of this study was to investigate the relationship between employability skills and CBET implementation among TVET graduates in Kisumu County, Kenya, an area where there is currently no empirical support for the efficacy of CBET. Employers' opinions of graduates' preparation for the workforce were examined, and graduates' self-reported technical, cognitive, interpersonal, entrepreneurial, and digital abilities were evaluated. It also looked at the relationship between employability outcomes and CBET implementation fidelity, curriculum alignment, assessment procedures, trainer competency, instructional materials, and industry attachment. The Yamane formula was used to sample 132 trainers, 80 HODs, and 292 employers from a descriptive quantitative design that targeted 201 trainers, 100 HODs, and 1,200 employers. Five scale likert questionnaires were used to gather quantitative data. The results demonstrated that respondents believed CBET graduates had somewhat better technical and interpersonal abilities, but they rated cognitive, digital, and entrepreneurial competencies as moderate to poor. Employers verified comparable patterns, although pointing out persistent gaps in digital literacy and entrepreneurial readiness. Regression analysis revealed a statistically significant association between employability outcomes and CBET implementation fidelity, with curriculum alignment showing the strongest correlation. In addition to providing context-specific information on how CBET is functioning at the implementation level, an area that has not gotten much attention in other studies. The study revealed skill domains where CBET may not be yielding the intended effects. It recommended strengthening training in digital and entrepreneurship, improving trainer capacity and resources, and

increasing industry participation in order to promote the practical relevance of CBET and improve graduate job readiness.

Keywords: Competency-Based Education and Training, employability skills, skills Development,

Introduction

Employability skills are transferable competencies like cognitive, interpersonal, technical, behavioral, and self-management abilities that help graduates land, keep, and advance in a job, adjust to shifting demands at work, and contribute successfully in work environments Suriona and (Mohd, 2023 and Omutange, Mutai, and Barasa, 2025). Employability in the TVET setting includes soft skills like communication, teamwork, problem-solving, digital literacy, punctuality, and work ethic in addition to technical skills (the abilities unique to a profession or occupation).

A research conducted by Omutange *et al*., (2025) noted that employers frequently complained that workers lacked system and technology application skills, whereas businesses placed a greater emphasis on information, interpersonal, and resource/capability skills. According to a different study conducted in Meru County, TVET graduates' development of employable skills is strongly correlated with industrial engagement, including internships and attachments (Mutembei, Kibaara, & Gichohi, 2024). The term "competence-based education and training" (CBET) is a method of curriculum design, instruction, learning, and evaluation that focuses on observable competencies that trainees need to possess, be able to do, and act in professional or occupational situations. Through guaranteeing mastery of certain abilities, focusing on real-world, experiential learning, and matching training to occupational norms, CBET has been utilized globally to overcome skills mismatches (Jwan, 2022). To better fulfill the demands of the labor market, several nations have implemented CBET, or outcome-based/talent-oriented curricula, particularly in technical and vocational sectors (Jwan, 2022; Halik Bassah & Mohd Noor, 2023).

Lack of proper infrastructure, inadequately prepared teachers, curriculum that isn't in line with workplace demands, and issues with certification and assessment are common obstacles to global implementation. Many African nations, including South Africa, Ethiopia, Ghana, Tanzania, Rwanda, and Malawi, have implemented CBET on a regional level (Jwan, 2022). Although CBET is typically supported by national policies, implementation is usually hindered by a lack of resources, a lack of industry involvement, and a lack of awareness among stakeholders and trainers (Jwan, 2022). For example, research has shown that insufficient teaching and learning resources, big class sizes, poor

instructor preparation, and inconsistent or delayed industry participation are all ongoing obstacles to successful CBET implementation in Kenya, Tanzania, and Rwanda (Jwan, 2022; Ringeera, Ngeera, & Muriithi, 2025; Were & Kitainge, 2021). To address long-standing concerns about the discrepancy between what graduates are trained to accomplish and what industries demand, CBET (or CBETA) has been formally implemented in the TVET sub-sector in Kenya.

According to the Kenya Association of Manufacturers (2017), TVET graduates lacked appropriate practical, trade-aligned skills because their curricula did not fit with industry demands. With changes like program modularization, dual training (50 percent industrial training, 50 percent coursework), and enhanced assessment through competency-based certification, Kenya has been moving toward full implementation of CBET in public TVET institutions since 2023 (Kenya Ministry of Education statements, Kenyan News Agency, 2025). Studies like those conducted at Nyeri National Polytechnic and in the Mt. Kenya East Region, however, point to significant gaps: trainers might not have the necessary resources or complete understanding to deliver CBET as intended, physical and ICT infrastructure is frequently insufficient, and instructional design processes are applied inconsistently (Ringeera et al., 2025; Were, Miseda, & Kitainge, 2021). These disparities cast doubt on the extent to which CBET has improved TVET graduates' employability skills in Kenya.

Problem Statement

Employability skills for TVET graduates encompass a blend of occupation-specific technical competencies and transferable skills such as communication, teamwork, problem solving, adaptability, work ethic, and basic ICT proficiency, that enable graduates to obtain, maintain and progress in decent work (National Skills Development Policy, 2023; Federation of Kenya Employers, 2023). The labour market situation in Kenya is mixed: although macro growth has been positive, with labour market indicators revealing structural issues that disproportionately impact young and vocationally trained cohorts. The unemployment rate is still quite high, where the youth unemployment is significantly higher than the national average and a significant proportion of employment in the low-productivity informal work (Labour Market Profile, 2024/2025). Data from the TVET subsector, has shown disparities in placement and graduation rates between trades and institutions with graduation rates ranging from 21% to 65% across the institutions while employer surveys continue to reveal persistent skills gaps, especially in digital skills, workplace-readiness behaviours, and practical competence when hiring TVET graduates (TVETA Annual Returns, 2023; Federation of Kenya Employers, 2023).

The trends imply that a large number of TVET graduates are either not certified

and placed in ways that convert training into respectable work or do not acquire adequate technical and employability skills required by employers. This undercuts TVET's contribution to national skill development and young employment. These issues could be addressed by implementation of CBET, which emphasizes demonstration of workplace-relevant competencies and aligns curricula, assessments, and certification with occupational standards (TVETA, 2023; Ministry of Education TVET Sub-sector Report, 2024). Implementation reports and industry feedback highlight ongoing limitations that limit CBET's ability to deliver the intended employability gains, despite the fact that the policy and standards (TVETS 01:2023 and related CBET guidance) clearly outline requirements for modular curricula, competency assessment, and industry engagement. These limitations include inadequate infrastructure and equipment, variable trainer capacity, uneven industry attachments, and gaps in assessment quality and data systems (TVETA Annual Returns, 2023). There is however limited comprehensive data showing how CBET enhances employability skills and labour-market outcomes for Kenyan TVET graduates despite the numerous policy documents and formative reports that outline the rollout of CBET. The evidence gap between CBET policy intent and systematic, outcome-level evaluation of graduate employability warrants research on the effectiveness of CBET in enhancing the employability skills of TVET graduates.

Objectives of the Study

The main objective of the study was to assess the effectiveness of Competency-Based Education and Training in enhancing employability skills among TVET Graduates in Kenya. The specific objectives of the study were to:

i. Measure the level of employability skills possessed by TVET graduates from CBET program in Kisumu County

ii. Evaluate the relationship between the fidelity of CBET and TVET graduates' employability skills in Kisumu County

iii. Examine employer perceptions of TVET CBET graduates' readiness for work in Kisumu County

Methodology

Research Design

This study adopted a descriptive research design using quantitative methods to investigate the effectiveness of Competency-Based Education and Training in Enhancing Employability Skills among TVET Graduates in Kenya. Questionnaires for quantitative data were used to obtain information from a selected sample of respondents, thereby allowing the researcher to describe

existing conditions, situations and phenomena in a systematic and detailed way (Osazevbaru & Mayuku, 2024).

Target Population

The population of the study consisted of TVET trainers, heads of departments, and employers who had trained or hired the CBET graduates within the past 2 years. The study targeted 100 heads of departments and 201 trainers from 33 institutions in Kisumu County. The study also targeted 1200 employers in Kisumu County.

Sample Size and Sampling Technique

The study's analysis centred on group members. This study employed Yamane (1967; cited in Israel, 2013) formula to calculate the sample size of the study, as:

$$n = N / (1 + N(e)^2)"$$

Where: *n* is the sample size

N is the population size

e is the level of precision (0.05).

As shown in Table 1, the sample distribution of the respondents was as follows:

Table 1

Sample Distribution of the population and Sample Sizes

Group	Population N	Calculated Sample Size *n*
Trainers	201	132
HODs	100	80
Employers	1,200	292
Total		**504**

Data Collection Instruments

Quantitative data from TVET trainers, HODs and employers sampled from Kisumu City were collected using both open and closed-ended questionnaires because questionnaires enabled the researchers to solicit respondents' views on the effectiveness of CBET on their experiences with the effectiveness of Competency-Based Education and Training in Enhancing Employability Skills among TVET Graduates in Kenya. The questionnaires used were constructed in Likert scales with five constructs: as:1- Strongly Disagree; 2- Disagree; 3- Neither Agree nor Disagree; 4- Agree 5- Strongly Agree to collect data on effectiveness of Competency-Based Education and Training in Enhancing Employability Skills among TVET Graduates in Kenya.

Data Analysis

Descriptive statistical techniques were applied with the Statistical Package for Social Sciences (SPSS) version 29 used to analyse such data. Descriptive statistics summarized and described the main features of the collected data in terms of Mean (average response per Likert item), Standard Deviation (variation in responses), Frequency Distribution, percentage of responses per scale point and tables. This was computed to present a general overview of trends and variations in responses (Pallant, 2023). Regression analysis was used to evaluate the relationship between the fidelity of CBET implementation (curriculum alignment, competency assessment, trainer competence, teaching resources, industry attachment) and graduates' employability skills

Results and Discussion

Level of Employability Skills Possessed by TVET Graduates from CBET program

The study sought to determine the level of employability skills (technical, cognitive, interpersonal, entrepreneurial, digital) possessed by CBET graduates. Respondents (TVET trainers, HODs and Employers) were asked to rate the level of employability skills (technical, cognitive, interpersonal, entrepreneurial, digital) possessed by the graduates. Table 2 shows the results.

Table 2

Level of employability skills possessed by TVET graduates from CBET program

Skill domain	Low (1–2) f (%)	Moderate (3) f (%)	High (4–5) f (%)	Mean±SD
Technical skills	48 (10.2%)	132 (28.0%)	292 (61.9%)	**4.05±0.65**
Cognitive skills (problem solving, critical thinking)	95 (20.1%)	165 (35.0%)	212 (44.9%)	**3.60±0.78**
Interpersonal skills (communication, teamwork)	71 (15.0%)	165 (35.0%)	236 (50.0%)	**3.72±0.71**
Entrepreneurial skills (opportunity identification, business planning)	165 (35.0%)	189 (40.0%)	118 (25.0%)	**3.02±0.95**
Digital skills (basic ICT, digital tools)	226 (48.0%)	142 (30.1%)	104 (22.0%)	**2.68±1.05**

The CBET graduates were viewed by employers as having strong technical and people skills but lacking in digital and entrepreneurial preparedness. The greatest ranking was given to technical skills (M = 4.05, SD = 0.65), with 61.9% of respondents responding that they were highly competent. In line with Mgaya (2022) in Tanzania and Spring Journals (2024) in Kenya, which emphasized enhanced practical skills and conformity to industry norms, this suggests that

CBET successfully gives students job-specific capabilities. With 44.9% of respondents identifying strong competence, cognitive abilities including critical thinking and problem-solving were modestly graded (M = 3.60, SD = 0.78). Even though a large percentage of graduates struggle with complicated problem-solving, many of them exhibit logical reasoning.

In a similar vein, the East African Journal of Education (2025) criticized CBET for prioritizing concrete technical results above abstract concepts. This emphasizes the necessity of inquiry-based and reflective methods to improve analytical skills. Relatively good interpersonal skills were rated as strong by half of respondents (M = 3.72, SD = 0.71). Graduates seem to have confidence in their ability to collaborate, communicate, and function as a team. This was ascribed by EAJES (2025) to group-based learning activities and industry attachments in CBET courses. Mack (2024) issued a warning, stating that the absence of systematic frameworks for evaluating soft skills restricts their acceptance in official certification. Only 25% of respondents gave entrepreneurial abilities a good ranking, indicating a lesser level of proficiency (M = 3.02, SD = 0.95). Given that many TVET colleges place a higher priority on creating job seekers than independent company owners, this indicates a lack of preparedness for self-employment.

According to Mack (2024) and EAJES (2025), entrepreneurship courses continue to be primarily academic and lack mentoring or actual incubation. Incorporating practical projects and mentoring might improve graduates' ability to recognize and seize business possibilities. The weakest category was found to be digital abilities (M = 2.68, SD = 1.05), with almost half of respondents pointing out shortcomings. This indicates a lack of ICT literacy and competency with digital tools, which are essential in today's business. Poor ICT infrastructure and a lack of integration of digital capabilities in CBET curriculum were the reasons given by Kholifah (2025). In a similar vein, Mgaya (2022) cautioned that CBET graduates will not be ready for technologically sophisticated fields unless digital tools and teacher upskilling are invested in. All things considered, CBET programs have been effective in improving technical and interpersonal skills, but they are still lacking in developing digital, entrepreneurial, and cognitive abilities.

Relationship between Fidelity of CBET Implementation and Graduates' Employability skills

The goal of the study was to analyze how graduates' employability skills and the integrity of CBET implementation which includes curriculum alignment, competency assessment, trainer competence, teaching materials, and industry attachment relate to one another. Therefore, the association was established

using multiple regression analysis. The results are displayed in the following tables.

Table 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.879	0.773	0.769	3.814

The five CBET fidelity characteristics together accounted for 77.3% (R2 =.773) of the variation in graduates' employability abilities, according to the model summary. This suggested that the skill preparedness of graduates entering the workforce and the adoption of CBET are highly predictive. After adjusting for the number of predictors, the model's robustness is further confirmed by the corrected R2 of.769. The findings implied that the effectiveness of curriculum design, assessment strategies, trainer preparation, and industry engagement directly enhance graduate employability outcomes. This is in line with Mulder and Winterton (2017), who highlighted that in competency-based systems, creating marketable graduates requires curriculum alignment and genuine assessment.

Table 4

ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	11235.46	5	2247.09	316.938	.000***
Residual	3305.18	466	7.09		
Total	**14540.64**	**471**			

Employability skills among graduates could be substantially predicted by CBET implementation fidelity, according to the ANOVA findings, which also revealed that the regression model was statistically significant (F (5,466) = 316.938, p <.001). This suggested that employability is significantly impacted by at least one of the CBET variables: curriculum alignment, assessment, trainer competency, instructional materials, or industry connection. These findings were in line with those of Oketch *et al.* (2022), who showed that graduates' work preparedness and job acquisition rates were significantly influenced by the effective operationalization of CBET at Kenyan TVET schools.

Table 5

Regression Coefficients

Predictor	B	Std. Error	Beta	t	Sig.
(Constant)	4.382	1.217	—	3.60	.000***
Curriculum Alignment (X_1)	0.284	0.051	0.278	5.57	.000***
Competency Assessment (X_2)	0.238	0.047	0.254	5.06	.000***
Trainer Competence (X_3)	0.198	0.043	0.217	4.60	.000***
Teaching Resources (X_4)	0.174	0.058	0.159	3.00	.003**
Industry Attachment (X_5)	0.221	0.049	0.233	4.51	.000***

All of the CBET fidelity components had a favorable and substantial impact on graduates' employability abilities, according to the regression results. The best predictor was curriculum alignment (β =.278, p <.001), emphasizing the significance of tying educational results to labor market demands. Industry attachment (β =.233, p <.001) and competency assessment (β =.254, p <.001) were also significant drivers, indicating that exposure to the workplace and practical evaluation techniques improve real-world abilities. The significance of trainer competence (β =.217, p <.001) supported the importance of knowledgeable and experienced teachers in skill transmission. Lastly, the impact of teaching resources (β =.159, p <.01) was moderate but substantial, highlighting the need of proper learning infrastructure and tools for skill development.

These findings were consistent with those of Marope *et al.* (2021), who showed that when trainers are well qualified and curriculum are in line with occupational norms, CBET implementation considerably improves employability outcomes. Similarly, Ngure (2020) noted that industry-attached competency-based programs enable graduates to acquire transferable and useful skills that are essential in today's job markets. The results of this study are also consistent with regional and international data on impact of CBET on employability. Oketch *et al*. (2022) also found that increased fidelity in CBET implementation increased job placement rates among TVET graduates in Kenya.

According to Marope *et al.* (2021), industry attachment and curriculum congruence are important factors that influence employability, which is consistent with the high beta coefficients for X_1 and X_5. Mulder and Winterton (2017) and Ngure (2020) further revealed that work preparedness and skill transfer are greatly impacted by trainer competency and resource sufficiency. The latest findings, however, go one step further by quantifying these impacts and demonstrating that curriculum alignment continues to be the most important

factor. This suggests that curriculum design improvements should be given priority in order to improve employment outcomes.

Employer Perceptions of TVET CBET Graduates' Readiness for Work

The study sought to establish employer perception of TVET CBET graduate readiness for work. Respondents (employers) were asked to indicate their level of agreement or disagreement with the following statements related to TVET CBET Graduates' Readiness for Work. Table 6 shows the results.

Table 6

Employer Perceptions of TVET CBET Graduates' Readiness for Work

Item (Employers' Perception)	Strongly Disagree f (%)	Disagree f (%)	Neutral f (%)	Agree f (%)	Strongly Agree f (%)	Mean	SD
1. TVET graduates demonstrate adequate technical competence	8 (2.7%)	20 (6.8%)	41 (14.0%)	139 (47.6%)	84 (28.8%)	3.94	0.83
2. Graduates possess good problem-solving and critical-thinking skills	21 (7.2%)	48 (16.4%)	91 (31.2%)	89 (30.5%)	43 (14.7%)	3.29	1.04
3. Graduates communicate effectively in the workplace	12 (4.1%)	29 (9.9%)	68 (23.3%)	127 (43.5%)	56 (19.2%)	3.63	0.96
4. Graduates work well in teams and collaborate effectively	9 (3.1%)	26 (8.9%)	62 (21.2%)	135 (46.2%)	60 (20.5%)	3.72	0.89
5. Graduates show adaptability and initiative in work settings	16 (5.5%)	42 (14.4%)	92 (31.5%)	102 (34.9%)	40 (13.7%)	3.37	0.97
6. Graduates demonstrate digital literacy and ICT competence	59 (20.2%)	78 (26.7%)	88 (30.1%)	51 (17.5%)	16 (5.5%)	2.61	1.08
7. Graduates display professionalism (punctuality, ethics, attitude)	5 (1.7%)	17 (5.8%)	54 (18.5%)	136 (46.6%)	80 (27.4%)	3.92	0.84
8. Graduates exhibit entrepreneurial readiness and innovation	62 (21.2%)	77 (26.4%)	95 (32.5%)	43 (14.7%)	15 (5.1%)	2.56	1.05

Employers generally perceived TVET CBET graduates positively, though with notable variation across employability dimensions. With more than 70% of employers confirming these qualities, technical proficiency (M = 3.94) and workplace professionalism (M = 3.92) received the highest scores. In line with findings from Mgaya (2022) in Tanzania and the Department of Higher Education and Training (2024) in Kenya, which both emphasized CBET's superiority over traditional content-based systems in producing technically capable and professional graduates, this suggests that CBET programs are successful in providing students with occupation-specific skills and professional discipline. Only 45% of employers agreed, with moderate grades in critical thinking and problem-solving (M = 3.29). This implies that operational abilities, not higher-order reasoning, are where CBET excels. In a similar vein, Mengistu and Negasie (2025) observed that graduates in Eastern Africa do exceptionally well on regular tasks but find it difficult to make decisions in dynamic situations. This suggests that in order to promote cognitive flexibility, inquiry-based and reflective learning strategies are required.

Nearly two-thirds of employers recognized the relatively strong communication (M = 3.63) and teamwork (M = 3.72) skills. Hartini (2025) ascribed these results to initiatives that prioritized cooperation inside CBET frameworks. Holidi (2023), however, issued a warning that inconsistent development and assessment of soft skills might result from the lack of established instruments for doing so. Employers' doubts about graduates' capacity to succeed in challenging or evolving contexts are reflected in the moderate ratings given to initiative and adaptability (M = 3.37). Spring Journals (2024) identified limited exposure to multi-contextual work simulations and weak industry linkages as key barriers to adaptability.

Digital literacy (M = 2.61) and entrepreneurial readiness (M = 2.56) were the domains with the lowest scores. Due to antiquated facilities and inadequate digital integration in CBET curriculum, over half of companies have doubts about graduates' ICT proficiency (Kholifah, 2025). According to Mack (2024), training is still primarily academic and lacks mentoring and practical incubation, and just 20% of companies thought graduates were ready for entrepreneurship. These shortcomings imply that while CBET schools are generating technically proficient workers, they are not developing independent innovators. Employers often see CBET graduates as professionally disciplined and technically proficient, but deficient in digital, cognitive, and entrepreneurial skills.

Conclusion and Recommendations

Conclusions

The results from the study showed that graduates' employability is greatly improved by adoption of CBET in TVET institutions, especially in the technical and interpersonal trade areas. Strong job-specific abilities were displayed by graduates, demonstrating CBET's effectiveness in filling conventional skill gaps in occupational performance. The moderate to low levels of cognitive, digital, and entrepreneurial abilities showed that although CBET improved practical execution, it failed to promote the creativity, flexibility, and digital literacy required for 21st century workplaces. Generally, employers appreciated that CBET graduates were capable and well-behaved, although they were less equipped for jobs requiring a lot of digital skills or self-employment. Additionally, employability outcomes and the fidelity of CBET implementation were found to be strongly positively correlated by the regression results ($R2 = 0.773$), confirming the importance of well-aligned curricula, authentic assessments, qualified trainers, sufficient resources, and solid industry connections in determining graduate readiness. The best predictor of employability was found to be curriculum alignment, which was closely followed by competence assessment and industry connection. This suggests that relating training results to actual occupational norms significantly improves work readiness. These results highlight how important it is to execute CBET consistently and well in order to produce graduates who are not just marketable but also flexible and creative workers.

Recommendations

The comprehensive graduation readiness could be guaranteed through integration of digital and entrepreneurial training within all CBET programs. Integrating hands-on digital modules, ICT-based evaluations, and experience entrepreneurship education via incubators, mentoring programs, and company simulations could help achieve this. A balanced approach to CBET implementation that prioritizes not just technical proficiency but also critical thinking, creativity, and self-reliance should be encouraged by policymakers in order to produce graduates who can succeed in both job and self-employment settings. In order to support technology transfer and creativity among trainees, formal partnerships with digital industries and entrepreneurship centers should be established.

Moreover, frequent evaluations including industry stakeholders and ongoing curriculum alignment with changing labour market demands are necessary to improve the accuracy of CBET implementation. To improve cognitive talents, competency evaluation techniques should place a high priority on reflective

learning and real-world problem-solving exercises. To maintain instructional quality, governments and TVET authorities should fund upskilling programs for trainers and contemporary teaching materials. Graduates would be further guaranteed to learn pertinent, transferable, and future-focused skills if industry ties were strengthened through established apprenticeship programs and cooperative certification systems. In a more dynamic, technologically advanced economy, these reforms taken together will increase the efficacy of CBET and position TVET graduates as professionals who can compete worldwide.

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4

POLICY AND PRACTICE IN RECOGNITION OF PRIOR LEARNING IMPLEMENTATION FOR UPSKILLING AND FORMALIZING SKILLS

Assessing Institutional Readiness for Recognition of Prior Learning Implementation in Kenyan TVET Institutions

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Abstract

Recognition of Prior Learning (RPL) is a valuable process for validating non-formal and informal learning experiences worldwide. The Kenyan RPL Policy Framework 2024 established a procedure for recognizing learning that occurs during employment, apprenticeships, and informal learning. Despite this milestone, serious implementation gaps exist in the TVET subsector especially on institutional preparedness to scale up RPL. The main objective of this study was to assess the Readiness of TVET institutions in Kenya to Implement RPL. The specific objectives of the study were to: investigate the availability and adequacy of physical resources, equipment and materials needed in RPL teaching and assessment; determine the availability of trained RPL practitioners, assessors and verifiers within the institute; and assess the capacity of staff to implement RPL processes. The study targeted all accredited public TVET institutions (30 national polytechnics and 205 public TVCs). Permission to undertake the survey was sought from the Principal Secretary, the State Department for TVET. A stratified and simple random sampling technique was used to obtain the desired sample size. The stratification was based on categories of institutions and counties. An online questionnaire consisting of both open-ended and closed-ended questions was sent to the principals, Heads of departments, and tutors in the sampled institutions. Data analysis was undertaken using IBM SPSS Version 29. The findings revealed that the three readiness dimensions collectively explained 31.5% of the variance in overall readiness for RPL implementation, representing a large effect size. Findings further established that the candidate's assessment had not taken root in TVET institutions and implementation of RPL was still taking place at a slow pace.

Keywords: Recognition of prior learning, institutional readiness, capacity assessment.

Introduction

Recognition of Prior Learning (RPL) has been a valuable tool in validating non-formal and informal learning experiences worldwide. However, most developing countries that have attempted to leverage their human capital capabilities to the fullest have faced challenges in recognizing skills for the majority of the population in the informal sector. RPL provides an opportunity to ensure that workers' previous learning, both formal and informal, is identified and certified, leading to further advancement in the educational and professional career ladder. The introduction of the Kenya National Qualifications Framework Act, 2013, the National RPL Policy Framework, 2024, and the RPL Policy Framework, 2024 have helped in providing a strategic framework for formalizing learning that occurs as a result of employment, apprenticeships, and informal learning in Kenya. Despite these policy milestones, serious implementation gaps exist in the TVET sector with regard to institutional preparedness to scale up RPL.

The RPL Policy Framework in Kenya (2024) noted that about 92% of Kenyan youth have competencies gained informally and non-formally but they stay unrecognized, hence they become disadvantaged and cannot compete fairly in the labour market. Additionally, the 2019 ILO survey found that more than 83% of the workforce who drive Kenya's economy have skills but do not have formal qualifications. A study by Ligale *et al.* (2023) noted that the RPL implementation and adoption and adoption in Kenya was quite slow.

Research Objectives

The main objective of this study was to determine the readiness of TVET institutions in Kenya to implement RPL. The specific objectives were to:

i. Investigate the availability and adequacy of physical resources, equipment and materials needed in RPL process;

ii. Determine the availability of trained RPL practitioners, assessors and verifiers within the institutions; and

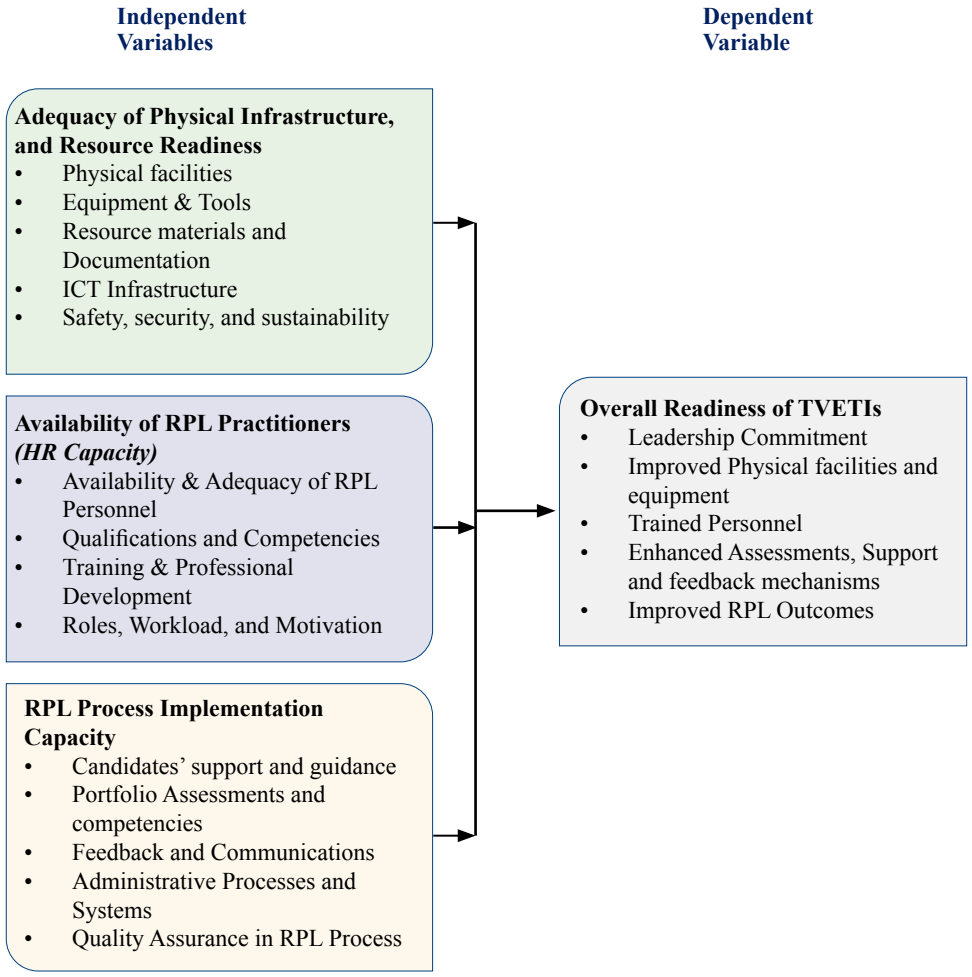
iii. Assess the capacity of staff to implement RPL processes, including the provision of support to candidates, portfolio assessment, and feedback communication.

Conceptual Framework

Figure 1 shows the conceptual framework on the relationship between the independent and dependent variables in this study.

Figure 1

Conceptual Framework on the relationship of the three readiness dimensions



The literature review examined RPL readiness and adoption in TVET institutions using four main dimensions: physical infrastructure, human resource capacity, process implementation, and institutional policy framework. The study was guided by Freeman's (1984) Stakeholder Theory, which postulates that institutional success depends on how well it manages relationship with key stakeholders. When this theory is applied in an educational context, as Ezeh *et al.* (2024) explain, it shows that effective stakeholder engagement results in better programme design and higher acceptance of RPL systems.

Methodology

The study targeted 197 TVET institutions with a total population of 13,274 trainers, of which 3,877 were from National Polytechnics and 9,397 were from TVCs. A proportionate stratified random sampling technique was used to select the respondents from this population (Creswell & Creswell, 2018). The sample size were set at 15% of the 13,274 trainers, resulting to sample of 1,992 respondents, comprising of 582 trainers from National Polytechnics and 1,410 from TVCs. The sample size was deemed sufficient for generalization, as it exceeded the minimum number suggested by Krejcie and Morgan (1970) for a population of similar size. Time was a major limitation to the study.

Results and Discussions

Response Rate

Out of the 1,992 targeted respondents, 1,130 responded to the survey tool, constituting 302 from National Polytechnics and 828 from TVCs. This translated to an overall response rate of 56.7%.

Demographic Analysis

Figure 2 shows the trainers years of experience while Figure 3 shows their highest qualifications.

Figure 2

Respondents Years of Service

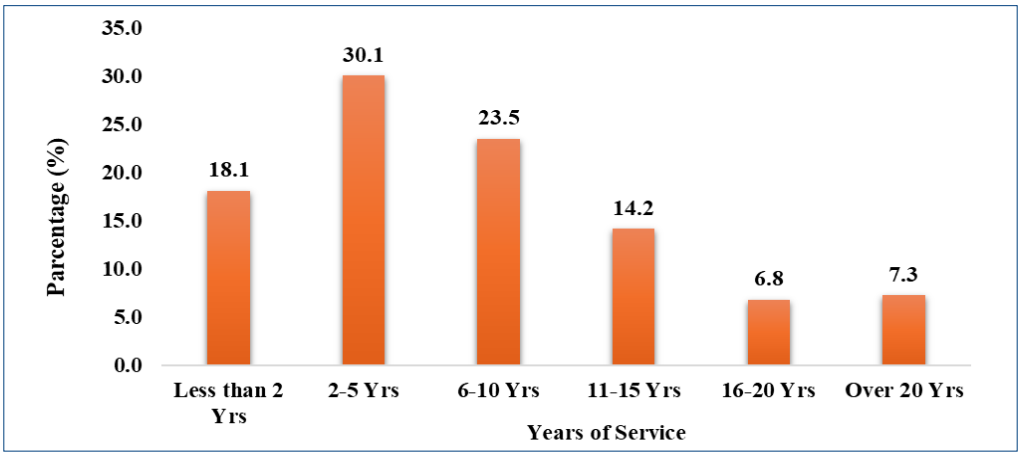
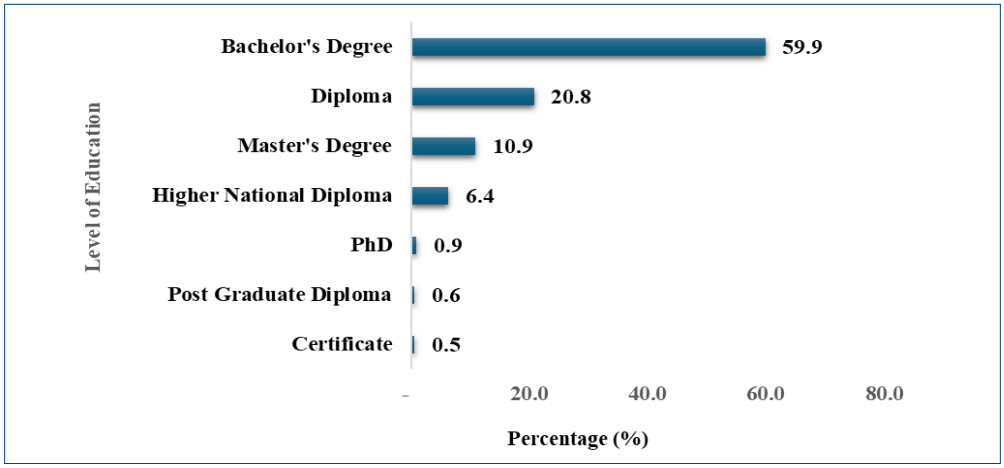


Figure 3

Respondents Level of Education



Majority (53.6%), of the trainers had served for between 2-10 years. Similarly, a most trainers (71.7%) had Diploma qualifications and above. The findings, therefore, showed that the trainers were suitably qualified and experienced.

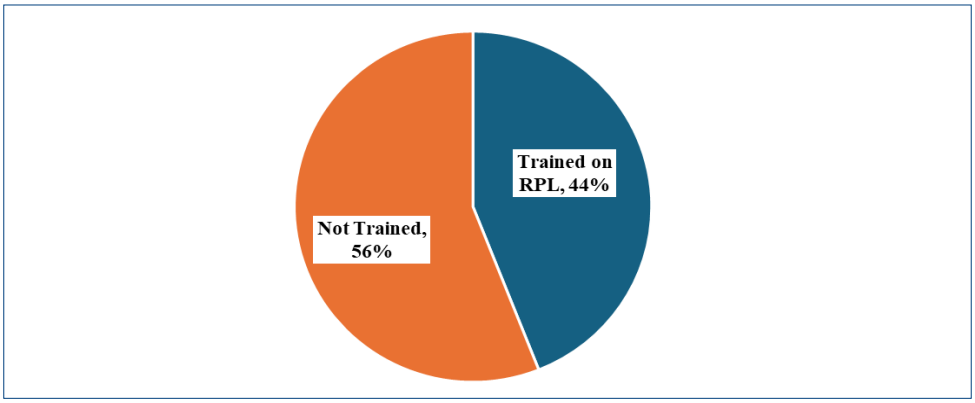
Institutional Analytics

Status of Training on RPL in TVET Institutes

Figure 4 presents the status of training on RPL in TVET institutes.

Figure 4

Status of TVET Tutors Trained on RPL



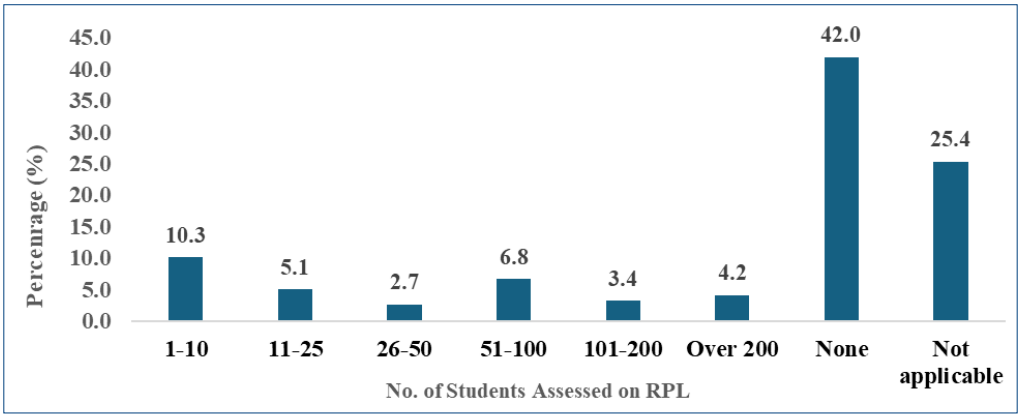
Out of the 1,130 respondents, 44% had been trained on RPL while 56% had not while out of the 497 respondents trained on RPL, 261 52.5% were trained on RPL assessment, 12.9% were trained on Competency Based Training, 12% attended RPL Coordination and Administration course while 6.7% attended Portfolio development and guidance.

Candidates Assessment on RPL

Figure 5 presents assessment status of students enrolled in RPL in TVET institutes.

Figure 5

Assessment Status of Students Enrolled for RPL in TVET Institutions



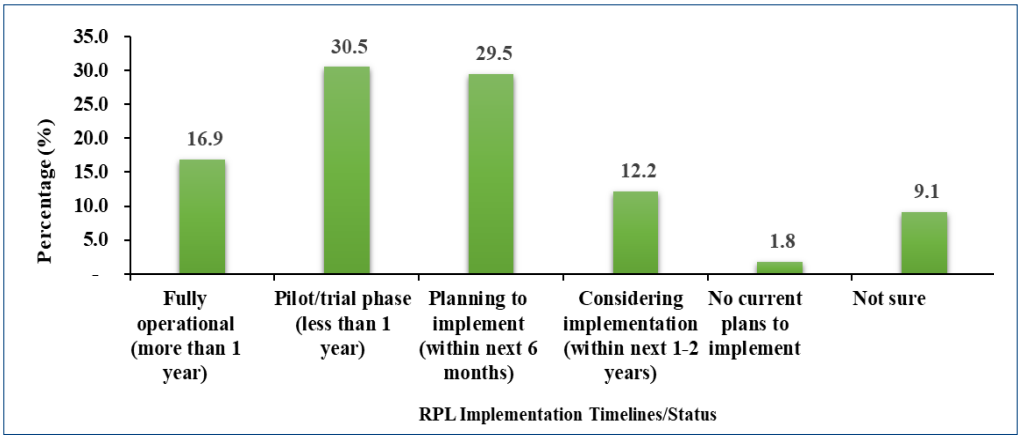
The majority of the respondents (42%) indicated that no candidate had been assessed. This was a clear indication that candidate's assessment had not taken root in TVET institutes.

Status of RPL implementation in TVET institutes

Figure 6 shows the status of RPL implementation in various TVET institutions that were under study.

Figure 6

RPL Implementation Status in TVET Institutions



The majority of the respondents 30.5% indicated that their institutions were implementing RPL on a trial basis. This was followed by 29.5% who indicated that the institutions were planning to implement RPL within the next six months,

while 12.2% indicated that the institutions were planning to implement RPL within 1-2 years. In addition, 16.9% respondents indicated that RPL had been fully operational in their institutions for more than 1 year, 1.8% indicated that there were no plans to introduce RPL, while 9.1% were not sure. This was an indication that the implementation of RPL in TVET institutes was at a slow pace.

Support Required for TVET Institutes to Effectively Implement RPL

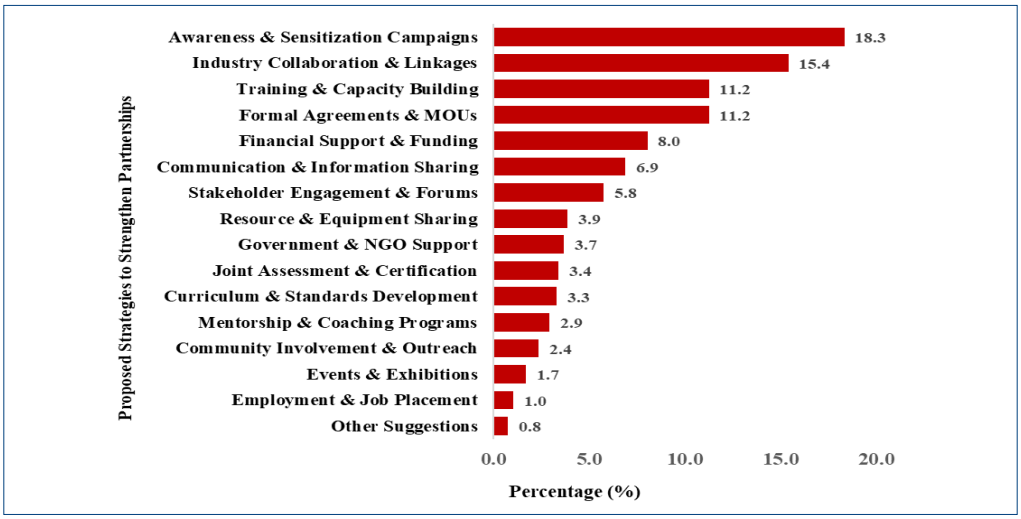
The support programmes that were proposed for successful implementation of RPL in TVET institutions included provision of adequate resources (33.7%), training and capacity building programmes (32.4%), adequate funding for infrastructure development and provision of equipment, workshops and laboratories (26.1%). Other proposed support programmes were policy guidance and provision of technical assistance as cited by 5.5% and 2.3% of the respondents respectively.

Strengthening Partnerships Between TVET Institutions, Industry and Community Organizations

The respondents proposed various ways of strengthening partnerships between TVET institutes, Industry and Community Organizations as presented in Figure 7.

Figure 7

Proposed Strategies to Strengthen Partnerships in TVET Institutions



The majority of the respondents (18.3%) cited organizing awareness and sensitization campaigns, this was followed by strengthening industry collaboration and linkages 15.4%.

Analysis of Study Variables

Adequacy of Physical Infrastructure and Resource Readiness

An independent samples t-test was conducted to determine the statistical significant differences in physical infrastructure and resource readiness between National Polytechnics and Technical and Vocational Colleges (TVCs) regarding their preparedness for the adoption of Recognition of Prior Learning (RPL). The indicators considered for Physical Infrastructure and Resource Readiness were measured using a composite scale comprising five indicator domains, namely: Physical Facilities; Equipment and Tools; Resource Materials and Documentation; ICT Infrastructure; Safety, Security, and Sustainability. Table 1 presents the descriptive statistics for physical infrastructure and resource readiness.

Table 1

T-test Analysis of Mean Rating for Respondents' Views on the Items for Physical Infrastructure and Resource Readiness

Group Statistics

Category	N	Mean	Std. Dev.	Mean Difference	d	t	Sig. (2-tailed)	Decision
Polytechnics	302	4.129	0.449	0.071	1128	2.584	.010*	*Significant.*
TVCs	828	4.058	0.391					

Note. *M = Mean; SD = Standard Deviation, **p < .01.*

The independent samples t-test revealed a statistically significant difference in physical infrastructure and resource readiness between National Polytechnics (M = 4.129, SD = 0.449) and TVCs (M = 4.058, SD = 0.391), with mean difference of 0.071. National Polytechnics exhibited a higher level of infrastructure readiness compared to the TVCs. These findings are similar to Keevy and Chakroun (2015), who found that well-resourced TVET colleges in South Africa had more capacity for RPL implementation because they already had established assessment infrastructure.

Both types of institutions (National Polytechnics and TVCs) demonstrated high readiness levels (means above 4.0 on a 5-point scale), which suggests an overall positive attitude toward RPL implementation. However, the statistically significant difference (p = .010) exhibited a notable gap in infrastructure preparedness between these two institutional categories. Also, both the National Polytechnics and the TVCs demonstrated relatively high readiness scores for safety, security, and sustainability (means > 4.0), which showed that they complied with safety and security requirements.

Availability of Trained RPL Practitioners or Human Resource Capacity (HRC)

The HRC was measured using a composite scale comprising of four indicators: availability and adequacy of RPL staff, staff qualification and competency, training and professional development received, and staff roles, workload and motivation. An independent sample t-test was conducted to compare HRC scores between National Polytechnic and TVCs. Table 2 shows the descriptive statistics and t-test analysis for HRC across the TVET institutes.

Table 2

T-test Analysis of Mean Rating for Respondents' Views on the Items for Human Resource Capacity

Group Statistics

Category	N	Mean	Std. Dev.	Mean Difference	d	t	Sig. (2-tailed)	Decision
Polytechnics	302	4.131	0.359	0.078	1128	3.203	.001**	*Significant.*
TVCs	828	4.053	0.365					

***p* < .01.*

The independent samples t-test demonstrated a statistically significant difference in HRC between National Polytechnics and TVCs, *t(1,128) = 3.203, p = .001, two-tailed.* The mean difference was 0.078, indicating that National Polytechnics scored higher on human resource capacity compared to TVCs. Further, National Polytechnics had higher capacity levels across the four indicators: Availability and Adequacy of RPL Personnel, Qualifications and Competencies, Training and Professional Development, and Roles, Workload, and Motivation.

Provision of Support to Candidates, Portfolio Assessment, and Feedback

The RPL process implementation capacity was measured using a composite scale made up of five indicator domains, which included: candidates support and guidance; portfolio assessment competence; feedback and communication; administrative processes and systems; and quality assurance in RPL Process. An independent samples t-test was performed to compare RPL process implementation capacity scores between National Polytechnics and TVCs, and the results are presented in Table 3.

Table 3

T-test Analysis of Mean Rating for Respondents' Views on the Items for RPL Process Implementation Capacity

Group Statistics

Category	N	Mean	Std. Dev.	Mean Difference	d	t	Sig. (2-tailed)	Decision
Polytechnics	302	4.066	0.484	0.071	1128	2.323	.020*	*Significant.*
TVCs	828	3.995	0.444					

*$p < .05$.

The independent sample t-test revealed a statistically significant difference in RPL Process Implementation Capacity between National Polytechnics and TVCs (two-tailed). The mean difference was 0.071, signifying that National Polytechnics scored higher on process implementation capacity compared to TVCs. This finding is in line with existing literature, which has documented process capacity disparities across TVET institutions (Baumeler *et al.,* 2023; Salzmann *et al.,* 2024) and also in the Kenya RPL implementation context (KNQA, 2024; Ministry of Education, 2024).

Overall Readiness of TVETIs to Implement RPL

Overall readiness was measured as a composite score that combined three dimensions: Physical Infrastructure and Resource Readiness, Human Resource Capacity, and RPL Process Implementation Capacity. Mean scores was interpreted using readiness threshold criteria that was defined as follows: Not Ready (1.00–1.50), which indicated fundamental capacity gaps that prevented RPL implementation from taking place; Partially Ready (1.51–2.50), which showed there was still big gaps that require a lot of intervention before implementation; Moderately Ready (2.51–3.50), which indicated there was basic capacity but still some targeted improvements was required; and Ready (3.51–4.50), which meant the institution had adequate capacity for effective RPL implementation.

Samples ttest was done to determine and compare the overall readiness scores between National Polytechnics and TVCs. Table 4 presents the descriptive statistics and independent t-test results for overall RPL implementation readiness across TVET institutes.

Table 4

T-test Analysis of Mean Rating for Respondents' Views on Overall RPL Implementation Readiness

Group Statistics

Category	N	Mean	Std. Dev.	Mean Difference	df	t	Sig. (2-tailed)	Decision
Polytechnics	302	3.532	0.887	0.532	1128	8.511	< .001***	*Significant.*
TVCs	828	3.000	0.945					

****p < .001.*

The results revealed that overall RPL implementation readiness varied significantly across the institutions. National Polytechnics had a mean score of 3.53 (SD = 0.89), which placed them in the "Ready" category (3.51–4.50). On the other hand, TVCs had a lower mean score of 3.00 (SD = 0.94), placing them in the "Moderately Ready" category (2.51–3.50). This difference revealed a clear gap in preparedness of the two categories of TVET institutes in RPL implementation.

The independent sample t-test results confirmed this gap. The test showed a highly significant difference in overall RPL readiness between National Polytechnics and TVCs, $t(1128) = 8.511$, $p < .001$ *(two–tailed),* with a mean difference of 0.532. This implied that National Polytechnics scored much higher on readiness, indicating that they already had adequate infrastructure, human resource and operational process, to start RPL delivery. For TVCs, even though foundational capacity existed, they still needed to undertake more targeted improvement before they could implement RPL effectively.

Correlation Analysis

The survey sought to establish the association between TVET and industry engagements and the areas for collaboration. A Pearson correlation analysis was performed to determine how TVET institutes and industry engagement related to different collaboration areas and establish the strength of relationship.

The correlation results were explained using Schober *et al*. (2018) guidelines: negligible (0.00–0.10), weak positive (0.10–0.39), moderate positive (0.40–0.69), strong positive (0.70–0.89), and very strong positive (0.90–1.00). Table 5 presents the correlation matrix, displaying all the pairwise relationships between the study variables.

Table 5

Pearson Correlation Matrix for RPL Readiness Dimensions and Overall Readiness

Variables *(N = 1,130)*	**PIRR**	**HRC**	**RPIC**	**Overall**
PIRR	1	.672**	.610**	.453**
HRC	.672**	1	.750**	.504**
RPIC	.610**	.750**	1	.525**
Overall Readiness	.453**	.504**	.525**	1

Note: *PIRR = Physical Infrastructure and Resource Readiness; HRC = Human Resource Capacity; RPIC = RPL Process Implementation Capacity; Overall = Overall Readiness. **p < .001 (2-tailed).*

The Pearson correlation matrix revealed a strong positive relationship between all the variables *(N = 1,130, p < .001 for all correlations)*. These results revealed that the factors of institutional readiness for RPL adoption in Kenya's TVET sector were closely linked and they supported each other.

Correlations Among Readiness Dimensions

Human Resource Capacity and RPL Process Implementation Capacity

The strongest correlation was between Human Resource Capacity and RPL Process Implementation Capacity ($r = .750$, $p < .001$). This implied that institution which had more qualified, well trained and adequate RPL staff was more likely to show strong implementation of RPL process. Baumeler *et al.* (2023) found that workforce capacity significantly influenced how well RPL was implemented in the vocational education context.

Physical Infrastructure and Human Resource Capacity

The correlation between Physical Infrastructure, Resource Readiness, and Human Resource Capacity ($r = .672$, $p < .001$) revealed a moderate to strong positive relationship. World Bank, ILO and UNESCO (2023) observed that availability of adequate infrastructure created a better environment for staff to perform more effectively. However, when resources were inadequate, even well-qualified practitioners could not perform to their full potential.

Physical Infrastructure and RPL Process Implementation Capacity

The correlation analysis between Physical Infrastructure and Process Implementation Capacity ($r = .610$, $p < .001$) revealed a moderate to strong positive relationship. Raciti *et al.* (2024) identified resource availability as a very important success factor for RPL implementation. Also, the Kenya National Qualifications Authority RPL Quality Assurance Manual (2024) provide that assessment centres should have adequate facilities for practical demonstration,

theoretical assessments, and consultation with candidates for the RPL process to run effectively.

Correlation Between Readiness Dimensions and Overall Readiness

The link between each of the readiness dimensions and overall readiness provided clear understanding about how each component contributed to the whole institutional preparedness. All three dimensions revealed significant positive correlations with overall readiness, with size of r-values ranging from moderate to strong, signifying that improvement in one dimension led to an increase in overall readiness.

RPL Process Implementation Capacity and Overall Readiness

RPL Process Implementation Capacity results demonstrated a strong correlation with Overall Readiness ($r = .525$, $p < .001$). Process capacity included indicators such as candidate support and guidance, portfolio assessment skill, feedback and communication system, administrative system, and quality assurance. All these were practical, everyday elements that directly shaped the quality of service. Pokorny (2024) found that supportive guidance during the whole RPL journey had a significant influence on candidate outcomes.

Human Resource Capacity and Overall Readiness

Human Resource Capacity revealed a strong positive correlation with Overall Readiness *($r = .504$, $p < .001$)*. The ILO (2018) RPL Learning Package emphasized that having qualified practitioners, coordinators, advisor, assessors, and verifiers were very crucial for RPL system to be credible and effective.

Physical Infrastructure and Overall Readiness

Physical Infrastructure and Resource Readiness revealed a moderate positive correlation with Overall Readiness ($r = .453$, $p < .001$). Even though it was statistically significant, this correlation was the weakest among the three dimensions, which suggests that infrastructure, while important, was not the main factor determining overall institutional preparedness. This finding was similar to Schieske (2021), who established that infrastructure was a necessary but not sufficient condition for undertaking competency-based assessment effectively.

Therefore, while investment in infrastructure was still essential, the finding suggested that a change in policy, process, and workforce provided higher benefits for improving overall readiness. Hence, TVET institutes should put more priority on the "software" (policies, processes, people) together with the "hardware" (facilities, equipment) when planning RPL capacity building strategy.

Multiple Regression Analysis

To determine the overall readiness of TVET institutes in implementing RPL, multiple regression analysis was conducted to establish the contribution of each variable, while controlling the variances shared with the other predictors (Tabachnick & Fidell, 2019).

Model Summary and Overall Fit

The multiple regression model examined three readiness dimensions as predictors of Overall Readiness was statistically significant, *(F(3, 1126) = 172.751, p < .001)*. The multiple correlation coefficient computed was (R = .561), which revealed a strong relationship between the combined predictors and Overall Readiness. The coefficient of determination (R^2 = .315) indicated that the three readiness dimensions together explain 31.5% of the variance in Overall Readiness scores. The adjusted (R^2 = .313), accounted for the number of predictors, and further confirmed the model explanatory power.

According to Cohen's (1988) conventions for effect sizes in multiple regression, an R^2 of .380 represented a large effect size (where small = .02, medium = .13, large = .26). This implied that the three readiness dimensions had substantial practical significance for explaining variation in overall institutional preparedness for RPL implementation.

Analysis of Variance (ANOVA)

The ANOVA results confirmed that the regression model significantly predicted Overall Readiness, *F(4, 1126) = 172.751, p < .001*. The regression sum of squares (327.108) represented the variance explained by the model, while the residual sum of squares (710.703) represented the unexplained variance. The ratio of explained to unexplained variance yielded the highly significant F-statistic, indicating that the model performed substantially better than using the mean alone to predict Overall Readiness. Table 6 shows the ANOVA results.

Table 6

ANOVA Results for Multiple Regression Model

Source	*SS*	*df*	*MS*	*F*	*p*
Regression	327.108	3	109.036	172.751	.000[b]
Residual	710.703	1126	.631		
Total	1037.811	1129			

a. Dependent Variable: *Overall Readiness*

b. Predictors: (Constant), *RPL Process Implementation Capacity, Physical Infrastructure Resource Readiness (PIRR), Human Resource Capacity (HRC)*

Regression Coefficients and Individual Predictors

All three predictor variables made statistically significant contributions to predicting Overall Readiness. The standardised regression coefficients (β) enabled comparison of relative importance across predictors measured on different scales. Table 7 presents the regression coefficients statistics.

Table 7

Multiple Regression Coefficients Predicting Overall RPL Readiness

Predictor	*B*	*SE*	*β*	*t*	*p*
(Constant)	-2.734	.276		-9.889	.000
PIRR	.356	.080	.152	4.444	.000
HRC	.470	.107	.179	4.377	.000
RPIC	.626	.080	.298	7.793	.000

Note. *B = Unstandardized coefficient; SE = Standard Error; β = Standardized coefficient. PIRR = Physical Infrastructure and Resource Readiness; HRC = Human Resource Capacity; RPIC = RPL Process Implementation Capacity;*

The Regression Equation

Based on the unstandardised coefficients, the regression equation for predicting Overall Readiness was:

*Overall Readiness = – 2.734 + 0.356(PIRR) + 0.470(HRC) + 0.626(RPIC) +*Ɛ

This equation revealed that for each one-unit increase in RPIC, Overall Readiness increased by 0.626 units, holding other variables constant. Similarly, one-unit increase in HRC, and PIRR yielded increases of 0.470, and 0.356 units respectively, in Overall Readiness.

Interpretation of Individual Predictors

RPL Process Implementation Capacity

RPL Process Implementation Capacity was the strongest predictor of Overall Readiness *(β = .298, t = 7.793, p < .001)*. The process capacity indicators, which included candidate support, portfolio assessment competency, feedback mechanism, administrative systems and quality assurance, contributed significantly to the overall readiness beyond what was already explained by infrastructure, workforce and policy factor.

Human Resource Capacity

Human Resource Capacity was the second strongest predictor of Overall *Readiness (β = .179, t = 4.377, p < .001)*. This result established that staff availability, qualification, training, and workload made a significant contribution toward overall institution's preparedness, independent of infrastructure, process, and policies. This finding resonate with Baumeler *et al.* (2023), who found that

workforce capacity had a strong effect on RPL implementation outcome in the vocational education context.

Physical Infrastructure and Resource Readiness

Physical Infrastructure and Resource Readiness was found to be a significant predictor of Overall Readiness *(β = .152, t = 4.444, p p < .001)*. Infrastructure indicators such as facilities, equipment, ICT systems, resource materials, and safety provision contributed significantly to overall readiness. This finding resonates with the study conducted by Mukhtar and Ahmad (2015), who found that facilities, equipment, and physical resource availability constitute a meaningful independent predictor of assessment implementation in TVET institutions.

Policy Implications and Recommendations for Recognition of Prior Learning Implementation in TVET Institutes

The findings from the RPL readiness assessment revealed a significant difference across TVET Institutions, and this made it necessary to put more strategic and evidence-based policy interventions. Arising from the findings, the following recommendations are made:

Strategic Implementation Approach

For successful implementation of RPL, phased and differentiated approach model be adopted. National Polytechnics, which have attained "Ready" status, should be considered for RPL centre accreditation and be allowed to start registering candidates. The centres will act as early demonstration sites, thus building real implementation experience and practical best practices that will provide guidance to other TVET institutes that come on board.

TVCs which were classified as "Moderately Ready", should first go through some structured capacity building phase, so that their staff, system and facilities are more properly prepared and not overwhelmed. They should take time to improve how they assess people skill, organize document and manage the RPL process, otherwise the quality of recognition will not be consistent and it can create confusion for learners and employers. It is further recommended that regional clusters of these institutions could set up shared RPL assessment centres. Pooling resources between TVET institutes could lower cost, avoid duplication of efforts and offer wide range of RPL services, even if the institutes lacked adequate internal capacity.

Process Standardization and Implementation

The RPL Process Implementation Capacity offered a significant contribution and demonstrated the importance of having a standardized, and qualityassured process across different TVET institutes. The strong positive relationship between all the readiness dimension revealed that RPL worked more like a whole system, where infrastructure, human resource, process and policy were all linked together and depended on each other to shape the total institutional capacity. This more integrated approach implied that improving the process should happen together with developing the workforce, not as a single change factor.

Human Resource Capacity Development

Human Resource Capacity was established as the second strongest predictor identified for workforce development as a very high–leverage intervention for closing the readiness gap. It is recommended that the Kenya School of TVET expands its programmes to include specialized RPL practitioner certification courses, accessible to all TVET tutors.

Quality Assurance and Credibility Protection

The readiness gap presented a significant quality assurance risk, if it was escalated to implementation without building adequate capacity in TVET institutes. Premature rollout in the "moderately ready" category of institutions could generate poor quality assessment outcomes that erodes trust and credibility of RPL process. TVETA's role as regulator, should also assess and confirm readiness before giving accreditation to RPL centres, and undertake followup quality audits to ensure standards are kept, in accordance with the KNQA RPL Quality Assurance Manual.

Sustainable Financing Mechanisms

Financial sustainability emerged as a very important readiness dimension, that required more innovative financing approach. Working with industry partners and stakeholders offers a better chance of securing financing opportunities. Employers can pay for RPL assessment for their informal sector suppliers and sub-contractors. The Kenya National Federation of Jua Kali Associations could facilitate a group financing plan for member artisans who require official recognition of their skills. Sector-specific Skills Councils, being set up in Kenya, a model benchmarked from Gambia, could also improve RPL financing by introducing a sector training levy. Having diversified funding sources reduces over-reliance on the government budget allocations, and ensures that cost does not hinder economically challenged candidates to access access RPL.

Physical Infrastructure Investment

While Physical Infrastructure and Resource Readiness made the lowest contribution to overall readiness, it still remained a significant predictor and should not be ignored. The results established that infrastructure investment should be more strategic and targeted, not taking over the whole resource allocation. Introduction of mobile assessment units could facilitate RPL services to institutions that lacked permanent infrastructure, as recommended by UNESCO-UNEVOC in contexts where resources are limited. Public–private partnership with industry stakeholders could provide access to equipment for assessment without the institution having to acquire and keep them permanently.

Monitoring and Evaluation Framework

Closing the readiness gap need a more systematic approach to monitor institutional capacity development. The readiness assessment methodology that was used in this study provided a baseline upon which progress can be tracked over time. TVETA annual quality audits and research functions should include readiness indicators to monitor how TVET institutes are moving toward 'Ready' status. The set Key Performance Indicators ought to help track the number of TVET institutes advancing from 'Moderately Ready' to 'Ready' status. Also, establishment of a National Learners' Records Database, model adopted by South Africa's NLRD, should be used to capture RPL achievement data for system-wide monitoring, and this will enable evidence-based policy adjustment over the time.

Conclusion

The multiple regression analysing revealed that the three-readiness dimension together explained about 31.5% of the variance in Overall Readiness for RPL implementation. All three predictors were statistically significant, but they did not have same level of importance. RPL Process Implementation Capacity *(β = .298)* was the strongest predictor, followed by Human Resource Capacity (β = .179), while Physical Infrastructure and Resource Readiness (β = .152) showed the smallest contribution.

These findings have clear implications for resource allocations in Kenya's RPL implementation strategy. Workforce capacity building, and process standardisation the 'software' of institutional readiness should obtain proportionally more attention than infrastructure investments.

As Kenya operationalizes its RPL Policy Framework, the regression findings offer evidence-based guidance for maximizing return on capacity-building investment. TVET Institutes that are seeking to improve overall readiness

should prioritize workforce capacity building and process standardization, while infrastructure investments are targeted more strategically to address specific bottlenecks.

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